BUREAU OF MINERAL RESOURCES
DEPARTMENT OF MINERALS AND ENERGY

RECORD 1975/151

GEOPHYSICAL SURVEYS OF THE CONTINENTAL MARGINS OF AUSTRALIA, GULF OF PAPUA AND THE BISMARCK SEA

OCTOBER 1970 TO JANUARY 1973

OPERATIONS and TECHNIQUES

COMPAGNIE GENERALE DE GEOPHYSIQUE
6 RUE GALVANI, 91301 - MASSY - FRANCE.

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OPERATIONS AND TECHNIQUES

by

COMPAGNIE GENERALE DE GEOPHYSIQUE

* * * *

A marine geophysical survey of much of the Australian continental margin, the Gulf of Papua and the Bismarck Sea was conducted by Compagnie Generale de Geophysique (C.G.G.) under contract to the Bureau of Mineral Resources between September 1970 and January 1973. This report is one of five produced by C.G.G. covering different aspects of the work. The others are: Data processing (Record 1974/110), Equipment description (Record 1974/111), Systems performance (Record 1975/104) and Data quality and distribution (Record 1975/152).

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October 1970 - January 1973

OPERATIONS AND TECHNIQUES

COMPAGNIE GENERALE DE GEOPHYSIQUE
6 Rue Galvani - Massy FRANCE

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A P P E N D I X

Correspondence : calendar days, survey days.

SUMMARY

(by F.W. Brown, BMR)

The survey was conducted on a continuous, 24-hour basis at an operating speed as close to 10 knots as possible. A portable shore station was maintained at sites as near the survey area as possible, continuously recording variations in magnetic field strength and VLF/Omega transmissions. Later, the VLF/Omega equipment was transferred to the ship.

The supervisory staff comprised the Company's branch manager and the project chief scientist, both based in Canberra, responsible respectively for overall administrative management and scientific supervision of the project. The ship's scientific staff comprised: boat geophysicist, chief computer, computer draftsman, chief instrument engineer, deputy instrument engineer, chief navigator, 3 navigators, chief gravity/magnetic observer, chief seismic observer, 4 observers.

The ship was served by a crew of 26, and a boat manager who moved his base from port to port following the progress of the survey. The staff of the portable shore station comprised a radio technician/engineer and an operator both of whom also moved with the progress of the survey.

The base office for the survey was maintained continuously in Canberra with a staff comprising programmer/data processor, geophysicist/computer, computer/draftsman and secretarial staff as appropriate.

Daily activities at sea were related to operation of the data acquisition system, the seismic system and the satellite positioning system. Calculations were made of satellite pass parameters and resultant fix positions, dead reckoned positions intermediate to satellite fix positions, hourly Bouguer and free air gravity values and magnetic anomaly values. The hourly positions and values were plotted progressively on a transparent base at 1:1M scale and contoured. Misties and misclosures were determined and plotted. Standard procedures were followed before and during each cruise for preparing and operating seismic, gravity and magnetic equipment and monitoring data quality. Communications were maintained by radio and by supply boat. The variable weather conditions experienced throughout the survey affected its progress and the order in which particular areas were surveyed.

The total project was divided for administrative simplicity into a continuous series of 11 operational units, each called a survey. The surveys were subdivided into cruises which varied in duration from 15 to 25 days between official port calls.

In a general way, the surveys progressed around the continent clockwise from the northeast to the northwest.

Survey 5 covered much of the Bismarck Sea and Gulf of Papua, during the latter months of 1970. Survey 10, the next in the series, covered part of the northern Coral Sea, during a short period in December 1970. Survey 11 was preceded by several test cruises to determine the performance of various overhauled equipment and a revised digital data acquisition system. It was intended to cover the offshore area south of Tasmania, including the Tasmania Ridge, at the best time of the year for favourable weather, January to March. The weather was not favourable and coverage was incomplete. Survey 12 covered the east coast area from Gippsland north to about Maryborough from March to June 1971. Survey 13 extended the coverage northward to Cairns, ending in October. Survey 14 closed the gap from Cairns to the southern limit of Survey 10 and provided tie lines through surveys 12 and 13, from October to December, 1971. Survey 15 filled a gap along the eastern shore of Tasmania and the eastern reaches of Bass Strait between Hobart and Gippsland and then provided check traverses off the east coast generally in the area north to Maryborough covered previously by survey 12, from January to March 1972. During 2 cruises of this survey the gravity meter was under repair, off the ship. Survey 16 covered the area west of Tasmania and along the south coast of Australia west to the western end of the Great Australian Bight, from March to July 1972. Survey 17 extended up the west coast, mainly between Carnarvon and Broome, leaving a gap in the south to escape bad weather. A new digital data acquisition system was installed during this survey, designed by BMR. The survey lasted from July to October 1972. Survey 18 completed the west coast areas from the Arafura Sea in the north to the Naturaliste Plateau in the south, between September and December, 1972. Survey 19 consisted of one cruise needed to complete the coverage around the south coast from Cape Leeuwin to the Bight, including tie lines over the Naturaliste Plateau and into the Bight. It ended at Fremantle on 6 January 1973.

The report was prepared by C.G.G. BMR accepts its accuracy in general but not necessarily in every detail.

INTRODUCTION

The combined marine geophysical surveys of the Gulf of Papua and the Bismarck Sea and of the Continental Margins of Australia were carried out from September 4th, 1970 to January 6th, 1973 by Compagnie Generale de Geophysique for the Bureau of Mineral Resources, Department of National Development of the Commonwealth of Australia.

The aim of these seismic, gravity and magnetic surveys was to investigate the shallow sub-bottom, the extent of possible offshore sedimentary basins, the sedimentary structure down to some few thousand feet, and the regional basement tectonics.

The aim of this report is to describe the operations and techniques, the organisation and progress. When quoted in this report, the geophysical survey of the Gulf of Papua and the Bismarck Sea will be called survey 05 ; the geophysical survey of the Continental Margins of Australia will be represented by surveys 10 to 19. Figures 1 and 2 give the breakdown of the different areas.

BMR FIG. 1

GEOPHYSICAL SURVEY OF THE GULF OF PAPUA AND THE BISMARCK SEA

9/1970 to 12/1970

LOCATION MAP

1st cruise	lines	1 to 32
2nd "		33 - 86
3rd "		86 - 135
4th "		136 - 188
5th "		189 - 230

SCALE : 1 / 5,000,000

0 100 200 Km

CGG

SURVEY 05

141° 144° 147° 150° 153° 156°

0° 3° 6° 9° 12°

BISMARCK ARCHIPELAGO

BISMARCK SEA

NINIGO GROUP

ADMIRALTY ISLANDS

MANUS Island

ST MATTHIAS GROUP

NEW HANOVER

NEW IRELAND

PACIFIC OCEAN

RABAUL

WITU Islands

NEW BRITAIN

SOLOMON ISLANDS

BOUGAINVILLE ISLAND

MADANG

KARKAR I

LONG I

UMBOI I

IRIAN

NEW GUINEA

PAPUA

LAE

SOLOMON SEA

WEST

TROBRIAND I

D'ENTRECASTEAUX ISLANDS

WOODLARK I

PORT MORESBY

LINE 230

LINE 1

LINE 2

THE GREAT BARRIER REEF

LOUISADE ARCHIPELAGO

CORAL SEA

AUSTRALIA

FIG. 2

BMR

GEOPHYSICAL SURVEY OF THE CONTINENTAL MARGINS OF AUSTRALIA

12/1970 to 1/1973

SURVEYS AREA

SCALE: 1/20 000 000

0 200 400 600 km

CGG

SURVEYS 10 to 19

INDONESIA

WEST IRIAN

NEW GUINEA

PAPUA

NORTHERN TERRITORY

QUEENSLAND

WESTERN AUSTRALIA

SOUTH AUSTRALIA

NEW SOUTH WALES

VICTORIA

TASMANIA

MELBOURNE

CANBERRA

ADELAIDE

PERTH

HOBART

10

11

12

13

14

15

16

17

18

19

5°

15°

25°

35°

45°

110°

120°

130°

140°

150°

160°

170°

G E N E R A L

* The operations at sea were conducted on the basis defined by the following factors :

  - 24-hour per day operation of all sensors and navigation, with continuous tow of seismic cables.

  - Operation speed : 10 knots through the water.

  - Surveys conducted in units (or cruises) of 15 to 25 days at sea (Fig. 1 and 2).

* Magnetic daily variation and diurnal variations in V.L.F. propagation were recorded at a shore station. The position of the various sites is given Fig. 3.

* Ship-shore communications were constantly maintained throughout the whole survey.

* Overall organisation is given in Fig. 4.

* Staff structure is given in Fig. 5.

The breakdown of the various tasks between each member of the staff was as follows :

1. - Supervision staff

   - Branch manager : responsible for the overall management of the project.

   - Chief scientist : responsible for the overall scientific supervision of the integrated project.

FIG. 3

BMR

GEOPHYSICAL SURVEY OF THE CONTINENTAL MARGINS OF AUSTRALIA

12/1970 to 1/1973

SHORE STATIONS

SCALE: 1/20 000 000

0 200 400 600 km

CGG

110° 120° 130° 140° 150° 160° 170°

5° 15° 25° 35° 45°

WEST IRIAN

NEW GUINEA

PAPUA

INDONESIA

Port Moresby

Darwin

Cairns

NORTHERN TERRITORY

QUEENSLAND

Mackay

Onslow

WESTERN AUSTRALIA

SOUTH AUSTRALIA

Coffs Harbour

NEW SOUTH WALES

Coffin Bay

Emu pt

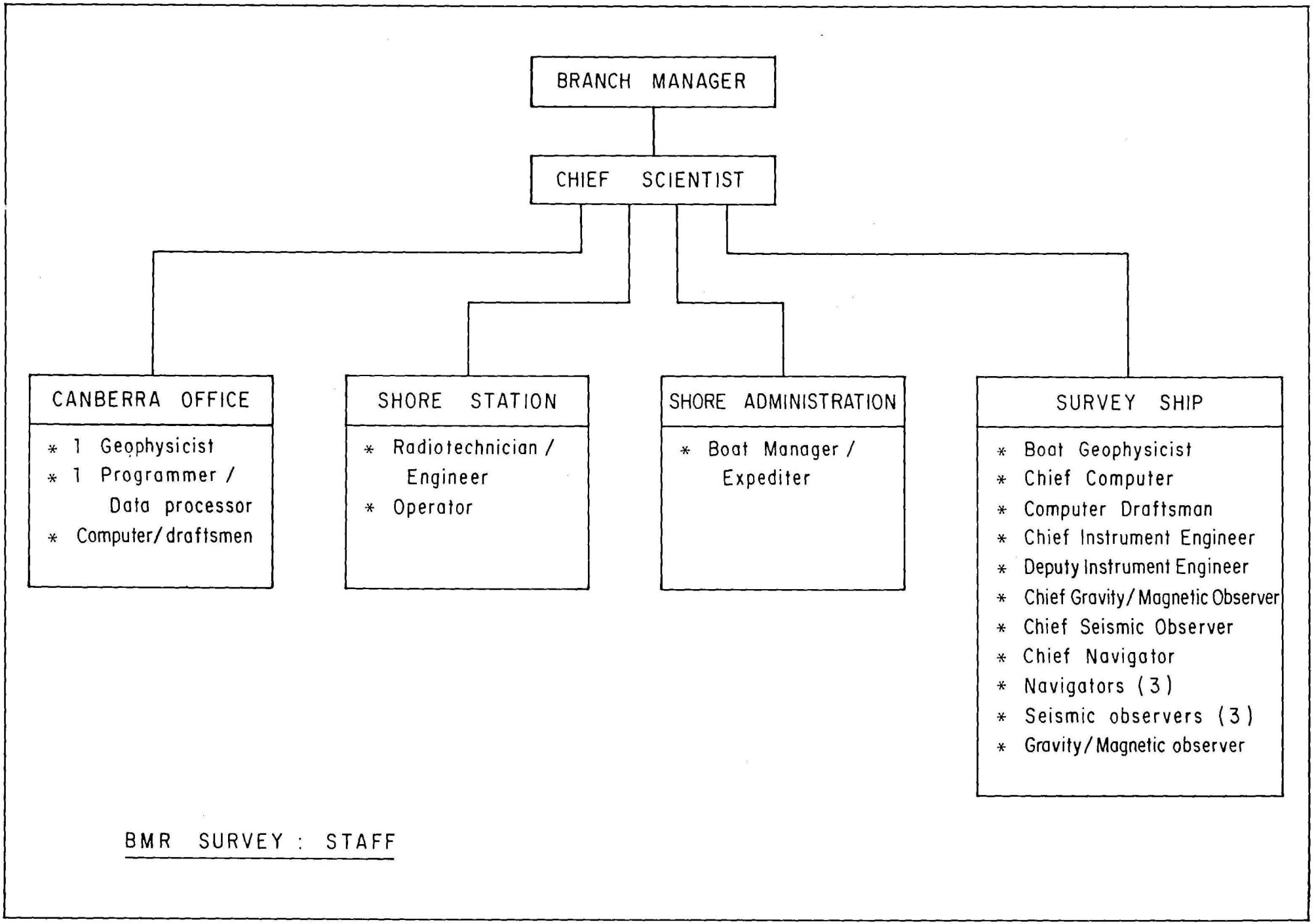
Albany

Eden

VICTORIA

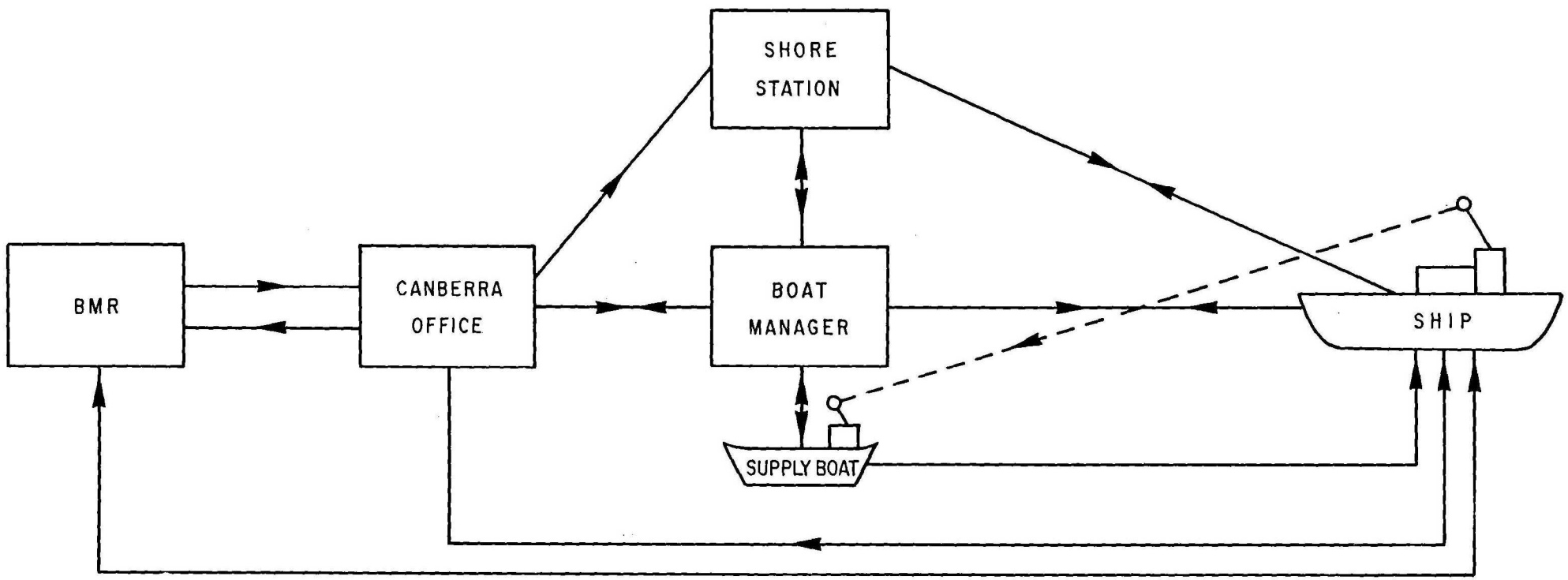
Launceston (2 st.)

Hobart



BMR SURVEY : STAFF

Fig. 4



FLOW DIAGRAM OF THE SURVEY ORGANISATION

Fig. 5

2. - Ship staff

- Boat geophysicist : responsible for ensuring

  i/ that all ship-board operations including boat handling, navigation and instrument operation are effected in a manner which will secure the best quality data for the attainment of the survey objectives.

  ii/ that all data are thoroughly checked.

  iii/ that preliminary data reduction is carried out in accordance with the requirements of the BMR.

- Boat manager : responsible for duties with regard to management of the ship except for essential scientific duties which are the responsability of the boat geophysicist.

- Chief computer : geophysicist responsible for on-board gravity, magnetic computing and seismic profile drafting.

- Computer draftsman : to assist the chief computer.

- Chief instrument engineer : responsible for supervision and/or execution of repair and maintenance of all scientific equipment, adequate preventive maintenance schedules, quality control routines, modification and integration of systems as may be required.

- Deputy instrument engineer : to assist and, when necessary, stand watches with or relieve the chief instrument engineer.

- Chief navigator : to supervise the navigation of the ship, ensure that correct operational procedures, required quality control checks and preventative maintenance are carried out.

- Chief gravity/Magnetic observer : to supervise the operation of the gravity and magnetic equipment, ensure that correct operational procedures required, quality control checks and preventative maintenance are carried out, stand watch on gravity and magnetic equipment.

- Chief seismic observer : to supervise the operation of the seismic equipment, ensure that correct operational procedures, quality control checks and preventative maintenance are carried out, stand watch on seismic equipment.

- Navigators : to operate navigational equipment, navigate ship, carry out quality control checks.

- Observer : to operate equipment, carry out quality control checks.

3. - Canberra office staff

- Programmer/Data processor : to supervise efficient computer processing of survey data.

- Geophysicist/computer : responsible, under the supervision of the chief scientist, for data organisation on shore, handling flow of data to and from computer centre ; to review and, where necessary, provide interpretation of computer output.

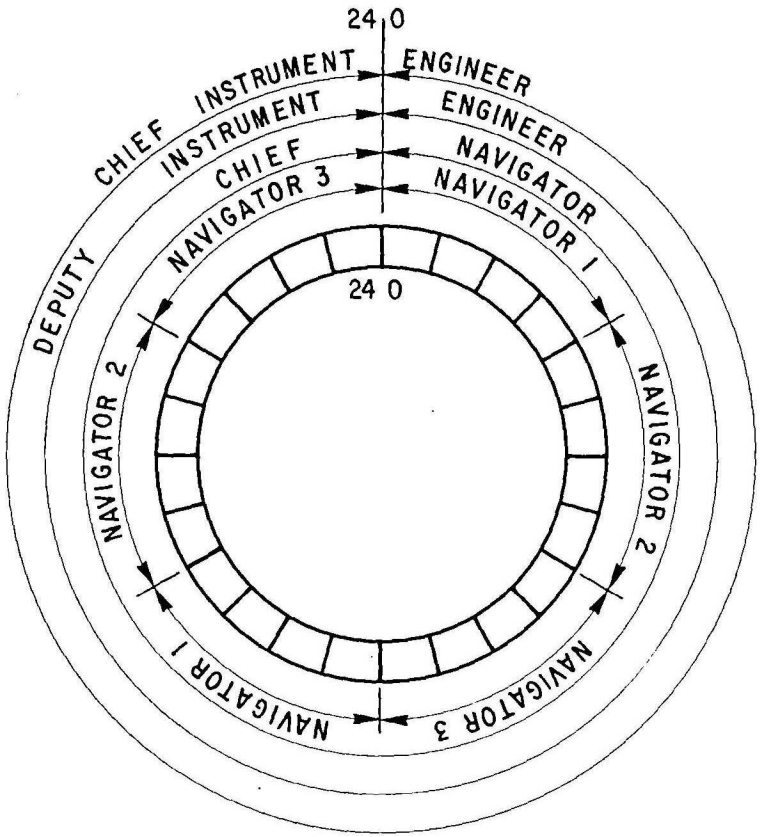
- Computer/draftsman : drafting work in the office.

4. - Shore station

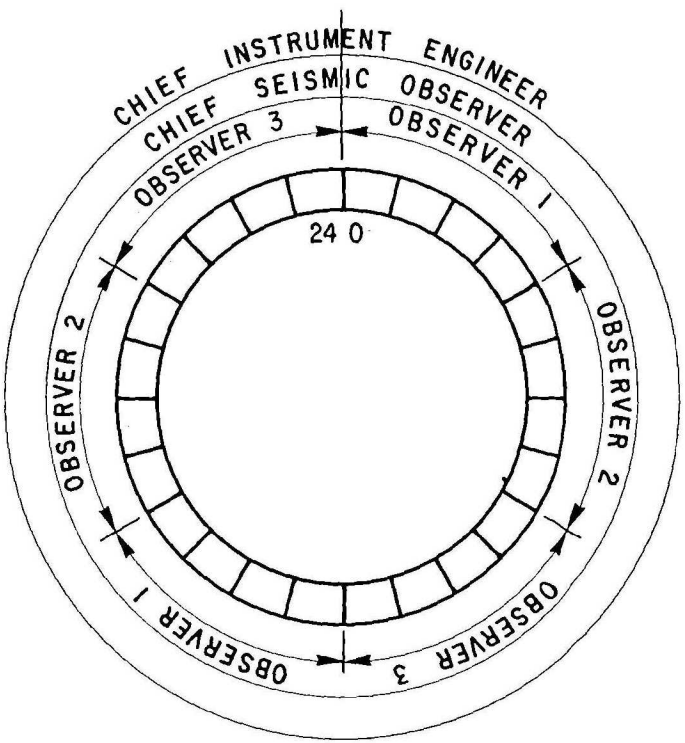
- Radio technician/engineer : responsible for maintenance and operation of shore station, carrying out quality control checks and preventative maintenance ; repairs and maintenance, maintaining communications with ship, geophysical computations of shore data.

- Operator : to assist radio technician/engineer.

* Roster organisation is given in Fig. 6.



NAVIGATION



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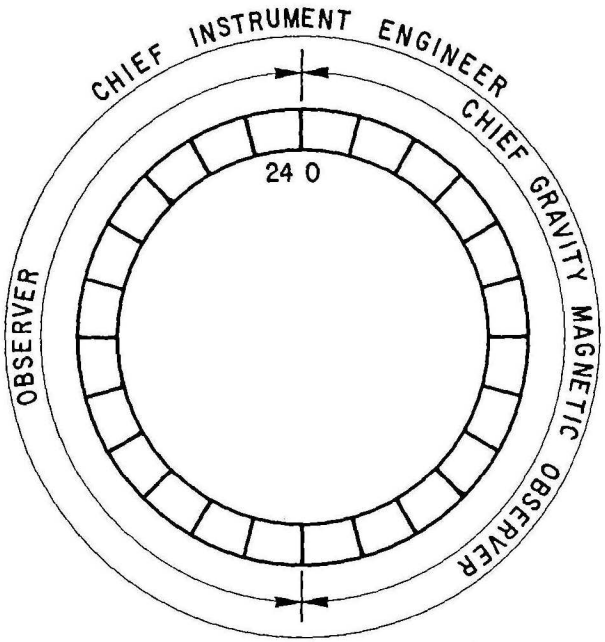


GRAVITY - MAGNETISM

ROSTER ORGANISATION

Fig. 6

I - SHIP

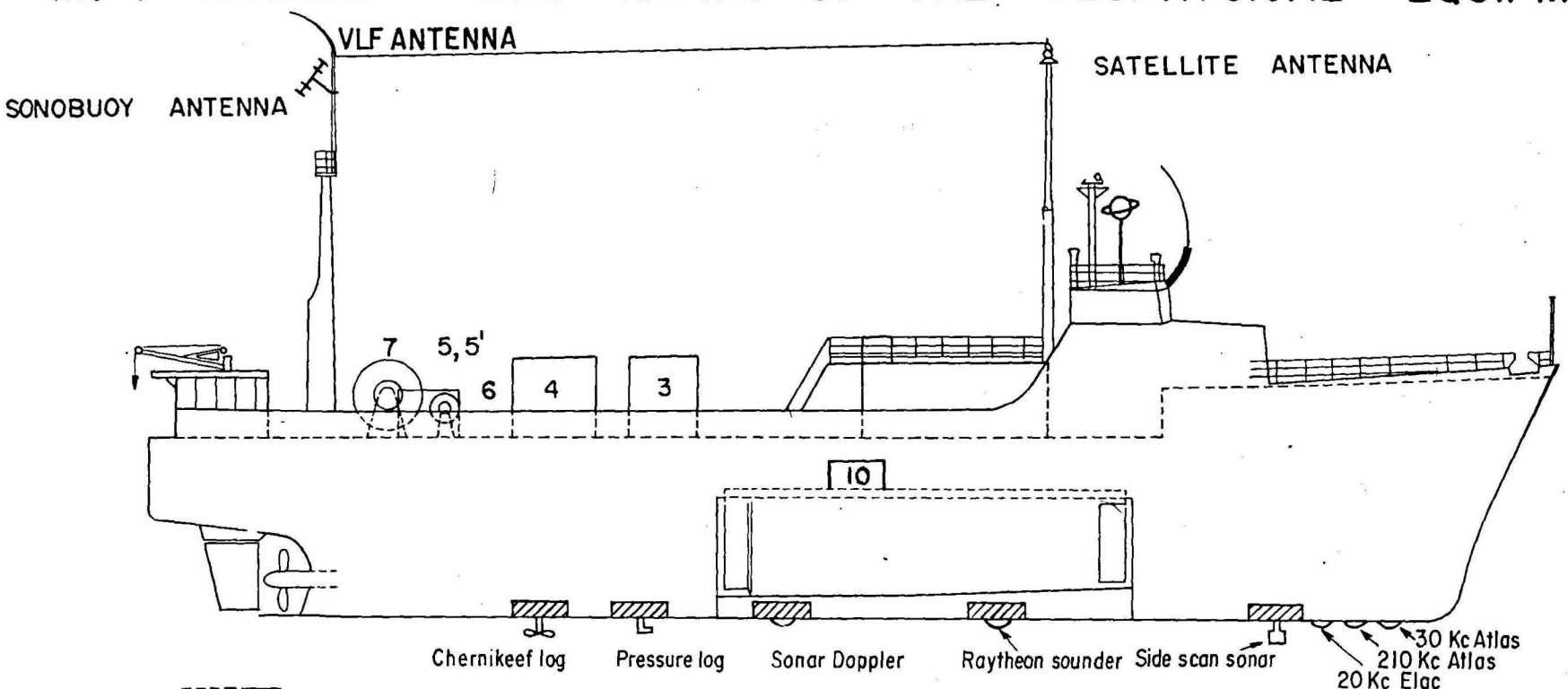
* The ship used was the motor vessel "HAMME" later rechristened "LADY CHRISTINE" whose main characteristics were as follows :

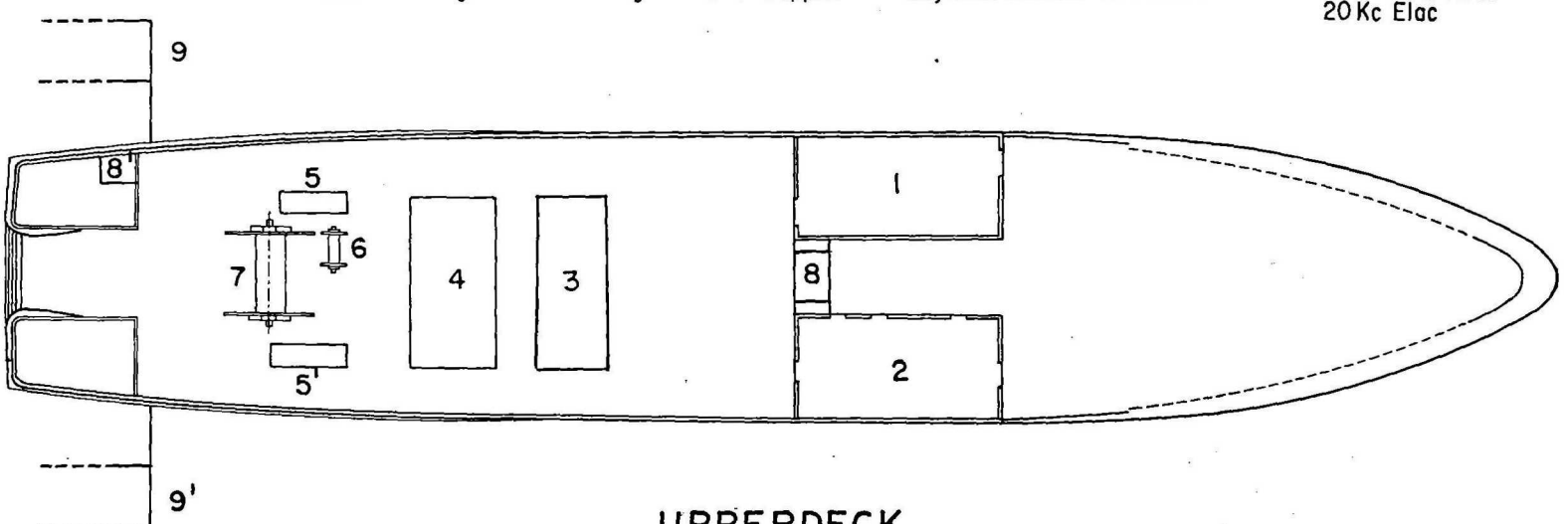
- Length : 54.5 m
- Beam : 10.2 m
- Draught : 4.6 m
- Gross tonnage : 769 tons
- Accommodation : 25 (geophysical personnel including BMR and visitors)
- Maximum speed : 13 knots
- Cruising speed : 8 to 10 knots with equipment under tow
- Endurance on continuous cruise : 20 to 25 days
- Special characteristic to ensure high stability : ballast

* The disposition of the various equipment is given in Fig. 7.

Area 1	:	Office
2	:	Navigation Room
3	:	Seismic container
4	:	Sparker container
5 and 5'	:	Sparker generator
6	:	Shallow seismic cable winch
7	:	Main seismic cable winch
8 then 8'	:	Magnetometer
9	:	Booms and Sparker electrodes.
Area 10	:	Gravity meter

M/V HAMME - BREAKDOWN OF THE GEOPHYSICAL EQUIPMENT





UPPERDECK

Fig. 7

II - TECHNIQUES - DAILY WORK

Two systems, each of them connected to a Hewlett-Packard model 2116-B computer were installed on board the ship.

II.1 - DATA ACQUISITION SYSTEM (Encl. 1)

Two programmes were successively used : first, CGG's MISER (from survey 05 to survey 16), and then BMR's JOY (from survey 17 to survey 19). In the two programmes, the following functions are performed :

- Formating and recording, in digital form, of all non seismic data, i.e. 32 channels (Fig. 8). Sampling rate : 10 seconds, triggered by a BMR master clock.

- Maintenance of an analysis of the reliability of the data recorded.

- Maintenance of dead reckoning.

- Production of regular print-outs required for checking and/or computation of results on board.

II.2 - MARINE SEISMIC SYSTEM (Encl. 2)

The seismic source was a 120 kilojoule GEOTECH Sparker emitting through 4 electrodes, until survey 16, cruise 1, then through 1 electrode from survey 16 cruise 2 to survey 19.

Two cables were towed, one with a single trace and the other with 6-traces. The first one, a GEOTECH cable with a 40 ft. long active section was designed for better resolution of high frequency shallow reflections. The second one, a CGG cable, was designed to receive deep reflections.

* A shot was fired every 50 metres providing four six-fold coverages intended to be processed on board as exploration proceeded, in the following way :

CHANNELS ON FIELD TAPE

Channel 1	Time
Channel 2	Gravity
Channel 3	Cross coupling
Channel 4	Total correction
Channel 5	Spring tension
Channel 6	Magnetic
Channel 7	Sonar Doppler North / South
Channel 8	Sonar Doppler East / West
Channel 9	Chernikeeff Log
Channel 10	Pressure Log
Channel 11	Heading
Channel 12	Depth
Channel 13	Anemometer (front)
Channel 14	Anemometer (lateral)
Channel 15	Sine of the heading
Channel 16	Cosine of the heading
Channels 17 to 24	V.L.F. Phases
Channels 25 to 30	V.L.F. amplitudes
Channels 31 and 32	Nil

* On certain tapes both channels 13 and 14 are replaced by 15 and 16 respectively.

- data converted to digital form by a Hewlett-Packard Multiverter, corrected for normal move-out and stored on a disc memory awaiting the corresponding C.D.P. traces

- when four consecutive CDP's are available, the four stacks are performed and mixed.

* A sonobuoy system was used for refraction tests. Due to unsuccessful attempts to use the Flexotir system as a refraction source, the source utilized was the GEOTECH sparker.

* Four graphic recorders were permanently used to record trace 2 of the long cable (at two different paper speeds), the Geotech cable, and a sequential play back of all the traces of the main cable and the Geotech cable.

Analogue magnetic recording was carried out on an Ampex recorder.

Note : A complete description of equipment and variations is given in the Report "EQUIPMENT DESCRIPTION".

II.3 - DAILY WORK - ON BOARD COMPUTATIONS

II.3.1 - Navigation

- Satellite precalculation

Prior to starting a cruise, the time of the satellite passes is precalculated using an "Alert Programme". This programme provides the navigator with the following information :

- rising time of the considered satellite
- culmination angle of the considered pass.

- Satellite fix computation

The satellite fix computation programme requires the introduction of the following external parameters :

- Approximate location of the receiver at the time of the pass
- Speed and heading of the ship at the time of the pass
- Height of the antenna above the geoïd
- Offset frequency.

These parameters are introduced via the teletype of the Transit system by the navigator.

Once the computation of the satellite fix is performed, a critical analysis of the result is carried out by the navigator. The quality criteria analysed are :

- the "residuals"
- the "offset frequency"

Residuals : the difference between the measured Doppler count and the corresponding theoretical count calculated from the location retained. For an accurate location, the residuals are, generally, smaller than 10. As a quality assessment, small residuals represent a necessary but not sufficient condition.

Offset frequency : a difference of more than 0.5 Hz between the calculated and the predicted values of the offset frequency indicates that a satellite fix must be rejected. A good agreement between the calculated and the predicted values of the offset frequency represents, as a quality control, a necessary and sufficient condition.

Once the quality criteria are satisfied, the fix (Lat. and Long.) accepted is introduced in the "Data Acquisition System", via its teletype, to reset the dead reckoning.

- Dead reckoning

Between satellite fixes, navigation data were extracted from three systems of dead reckoning maintained via the computer of the D.A.S. The three systems were :

- Sonar Doppler
- Chernikeeff log plus compass
- Pressure log plus compass

- Hourly positions

The linearly corrected hourly positions are necessary to carry out the geophysical computations and to draw the location map. Until survey 17, they were computed on a daily basis on the PDP - 8/I computer of the Transit system. From survey 17 to survey 19, their calculation was part of the new Data Acquisition Programme JOY designed by the BMR.

- V.L.F. computations

a - Using the shore monitor diurnal

The true ship range value is determined when a correction K, equal to the sum of the true range value at the shore monitor and the offset or phase error within the equipment at the shore monitor minus the phase error within the equipment at the ship, is known. Usually, K is determined at the start of a cruise. The true range value T_s is equal to : $(C_s - C_m) + K$

C_s : observed chart range value at the ship

C_m : observed chart range value at the shore monitor.

b - Using the ship diurnal

The true ship range value is determined when a correction M, called the shipboard diurnal, is known. M is equal to the sum of the

phase error within the equipment at the ship and the diurnal variation at the ship. The true range value T_s is equal to : C_s - M. M being determined at the times of satellite fixes.

- Office procedures

All relevant information was put down on special daily forms.

II.3.2 - Office tasks - Geophysical computation

- Bouguer anomaly - Free air anomaly

The Bouguer anomaly was computed on a hourly basis according to the following formula :

$$B = G - G_o + kH + 7.5 \frac{\Delta E}{\Delta T} \cos L$$

(Free air anomaly was computed but not contoured).

Where

- G is the value of gravity measured by the meter (LR model S 24)

- Go is the normal gravity depending on the latitude

- kH is the reduction of the water section (H) to a fixed density d. With H expressed in meters and a density of 2.2 :

$$k = 0.0419 \quad (d - I) \quad = \quad 0.05 \text{ approx.}$$

- the last term is the Eotvos correction reduced to the first order. L is the latitude ; $\frac{\Delta E}{\Delta T}$ is the eastward component of the speed in knots.

Note 1 : Tide correction is omitted.

Note 2 : G_o, Normal Gravity, is given by tables ; these tables were calculated every 6 minutes by the formula :

$$G_o = 978.0490 \quad (1 + 0.0052884 \sin^2 L - 0.0000059 \sin^2 2 L)$$

The one-minute values were obtained by parabolic interpolation. The intermediate values (1/10-minute) can be obtained by linear interpolation.

The hourly latitudes were read from the "Hourly position Print-Out" until survey 17, then, directly from the DAS printout from survey 17 to survey 19 - the corresponding normal gravity values were linearly interpolated on the tables previously cited.

Eotvos correction : the values of eastings and northings, from an arbitrary origin, were given in nautical miles by the Sonar Doppler. The determination of the eastward component of the speed was obtained by triplicating the difference of eastings 10 minutes before and after the hour considered. (From survey 16, East Doppler velocity was calculated by the DAS programme).

Gravity readings : Prior to the start of each cruise, gravity ties were carried out in order to link the S 24 gravity readings to the Australian network ; the gravity meter used was a Worden. The absolute reading (in the Australian network) given by the Worden allows the calculation of the zero of the Lacoste Romberg S 24 gravity meter.

Note : The Worden readings and the zero of the S 24 were calculated after all maintenance work had been carried out on the S 24. For the on-board computations, the zero calculated was assumed to have a non-significant drift during the cruise.

- Magnetic computations

They were calculated on a hourly basis ; magnetic anomaly values are given by the formula :

$$m = M - Mo - D$$

where :

- m is the magnetic anomaly value.

- M is the reading of the meter directly available in gammas (Varian Model V 4970).

- Mo is the normal IGRF value obtained by double interpolation, in precalculated tables provided by BMR, using the hourly positions.

- D is the diurnal variation recorded at the shore station and relayed to the ship by radio.

- Chart contouring

Chart contouring of Bouguer Anomaly, Magnetic Anomaly and Bathymetry was carried out on a cruise basis. The basic location map utilised was drawn using the hourly positions. The scale used was 1/1 000 000, then reduced to 40 miles to the inch for inclusion in the field progress reports and the final field progress report.

- Misties and misclosures

The respective intersection times of two crossing lines were calculated by a simple programme on the PDP - 8/I computer.

Corresponding gravity and magnetic values were taken from the analogue records. Eotvos and diurnal corrections were respectively applied. Water depths were read on the Elac or the seismic sections.

Differences at intersections are misties. Their sum, according to the trigonometric direction along a loop is a misclosure. Misties and misclosures were calculated for the whole survey.

II.3.3 - Seismic

- General

The standard work carried out by the chief seismic observer and

the seismic observers prior to and during a cruise was as follows :

- Prior to a cruise, exhaustive checks of all the seismic equipment, including the sparker room, are conducted in accordance with usual geophysical standards.

- During a cruise, noise tests and measurements of leakage and continuity of both cables at regular intervals. Amplifier tests at the beginning of every magnetic tape (i.e. approximately every 9 hours) consisting of check on output of all amplifiers and inspection of paper records for distortion, phase shift and excessive noise, checking of the depth of the two streamers.

- When the GEOTECH pneumatic device was working, checking at regular intervals of the depth of the electrodes.

- Maintenance every 48 hours of the Open Air thyratron of the monoelectrode system (from survey 16, cruise 2).

- Constant checking of the synchronisation of the four electrodes (prior to survey 16, cruise 2).

- Seismic cables

* Prior to a cruise : exhaustive check of the two cables, and, for the main cable, if necessary, repair or replacement of unsatisfactory traces ; subsequently, each time traces are changed, a polarity control is carried out. Once it has been checked, the Geotech cable is charged (batteries of the preamplifiers).

  The manometers of the main cable are calibrated.

* Operations at sea, before the official start of a cruise, static control : the main cable is put out to sea equipped only with three manometers (installed on traces 1, 3 and 6) and the tail buoy. After travelling for

a while, the engine is stopped. When the ship is motionless, the indications given by the three manometers must be very close to 0 (very slight negative buoyancy of the cable). If not, the unsatisfactory traces are refilled with kerosene.

When the very slight negative buoyancy is obtained, the cable is dynamically controlled : a leading plug (weight 70 kg) is added between the leading section and the neutral section preceding trace 1 ; 5 depth controllers are installed on traces 2, 3, 4, 5 and 6 and adjusted for the desired depth (10 or 15 meters depending on the area surveyed). Then, the indications given by the manometers are checked when the ship is in motion. If one section is not at the desired depth, the cable is pulled in and the corresponding depth controller(s) is/are readjusted. The operation is repeated until the manometer indications are satisfactory.

The final trimming can also be effected by means of thin sheets of lead hydrodynamically mapped around the trace and maintained by special adhesive tape.

* When the amount of repairs to be carried out on the traces of the main cable became considerable, the decision was made to install a "streamer workshop" on shore. It consisted, mainly, of a vacuum pump and hard plastic tubes with a diameter slightly larger than the diameter of the traces, the overall length of the assembled plastic tubes being 50 meters, i.e. the length of a trace. This workshop enabled the cable man to build completely new traces from spare parts received from the manufacturer or by using good elements taken from damaged traces.

- Refraction probes

They were carried out, at first with sonobuoys AN/SSQ - 41, and then with Aquatronix sonobuoys in the following way :

- (1) ship speed is reduced to six knots and shot interval set at 10 seconds.

- (2), a sonobuoy is dropped into the sea after investigation of the weather and sea state : waves, current, wind, in order to try and prevent the sonobuoy from colliding with one of the cables pulled behind the ship.

- If the dropping has been successful, recording of the seismic signal is carried out on 2 graphic recorders (2 different paper speeds). If not, a new sonobuoy is launched.

- At the end of the emission of the sonobuoy, ship speed and shot interval reverse to the usual working values.

II.3.4 - Gravity and Magnetism

Prior to the departure of the cruise, a gravity tie was carried out as described in paragraph II.3.2.

During a cruise, permanent watch was kept on gravity recorders : accelerometer, cross-coupling components and main recorder (G, T.C., C.C, S.T). Values of G every hour and S.T every four hours were put down, first for further computation and then for digital-analogue checking.

Before the official start, check on the magnetometer, by display of frequency reference was carried out ; during working time, a permanent watch was also kept and values of the magnetic field were put down every hour for further computation and recorder calibration control check.

II.3.5 - Shore station (Fig. 9)

Variations of the Earth's magnetic field were permanently recorded in an analogue way except during periods of breakdown or when the ship was sailing too far from the shore station location.

Monitoring and recording of diurnal variations in V.L.F. propagation was stopped at the end of survey 14, cruise 1.

SHORE - STATION LISTING

STATION	LAT.	LONG.	IGRF	FROM SS.DD	TO SS.DD
PORT MORESBY	09°25'	147°09'	43 082	05.01	10.09
HOBART	42°50'6	147°30'4	63 059	11.01	11.36
EDEN	37°04'2	149°53'1	60 038	12.01	12.16
COFFS HARBOUR	30°16'3	153°08'3	55 789	12.20	13.15
MACKAY	21°01'5	149°09'25	50 456	13.19	14.22
CAIRNS	16°45'70	145°40'52	48 003	14.28	14.58
LAUNCESTON I	41°24'44	147°06'07	62 492	14.76	15.45
LAUNCESTON II	41°33'30	147°16'10	62 536	15.86	16.18
COFFIN BAY	37°27'47	135°28'60	60 300	16.22	16.69
ALBANY	35°01'17	117°54'36	60 597	16.77	17.10
ONSLOW	21°38'25	115°06'58	52 891	17.16	18.11
DARWIN	12°25'50	130°49'90	46 447	18.19	18.45
EMU POINT	35°00'00	117°56'00	60 598	18.53	19.24

* Fig. 3 gives the various locations of the shore station during survey 05 and surveys 10 to 19.
* Fig. 9 shows the correspondance between surveys and locations.
* Shift of shore-station usually occurred during calls.
* Daily computations.

V.L.F. : The daily work consisted of :

- scaling 10-minute data by hand for all channels being recorded and listing on V.L.F. data sheet.
- extracting 1 hour data for transmission to ship.
- extracting V.L.F. data at times of satellites fixes.
- plotting 1 hour data for each channel on a continuing plot at a horizontal scale of 6" per day and a vertical scale of 2" per cycle.
- transmitting 1 hour and satellite data to the ship on a daily basis, when possible (see chapter "ship-shore communications").

Magnetic : The daily work consisted of :

- scaling 1-hour data and record on a magnetic survey computation sheet.
- correcting for the regional magnetic effect at the station (IGRF) and obtaining the magnetic diurnal.
- plotting 1-hour data diurnals on a continuing basis at a horizontal scale of 6" per day and a vertical scale of 20 gammas per inch.
- transmitting 1-hour data to the ship on a daily basis (see chapter "ship-shore communications").

Note : the shore station did not work from survey 15, cruise 2 to survey 15, cruise 4 when shore operations were resumed. The reason was a change in the order of operations : the survey ship went back to the East coast of Australia in order to carry out complementary work ; it was then decided that the shore station would not follow.

II.3.6 - Ship - Shore communications

Ship and shore station were linked by two SSB transceivers (at first 100 watt RCA during survey 05 and 10, and later 100 watt AWA from survey 11 to 19). The shore transceiver was set up either at the shore station, or at the boat manager's residence for easier communications. Communications were poor during survey 05 and impossible during survey 10 due to the poor quality of the ship transceiver. Consequently shore data were sent daily to the ship by wireless telegram via the ship radio-telephone.

From survey 11 to 19, ship-shore communications were generally satisfactory apart from some short breakdowns of the ship's transceiver. The ship radio telephone was used during these periods.

II.3.7 - Supply boats (Fig. 10)

- Supply boats were used to embark and disembark staff, visitors, equipment or supplies ...

- From survey 5 to 11, a supply boat (ARANDEL) was on permanent hire ; from survey 12, a supply boat was hired when necessary in the closer harbour where a ship was available for this task. If none was available, the ship had to sail to the port.

- Figure 10 gives a breakdown of the supply boats used during the whole survey.

- The unsatisfactory rendez-vous (either supply-boat not met or large amount of time lost in meeting the ship) were due to the following :

  - poor radio communications
  - poor or bad estimation of nautical parameters (wind, current) by the supply boat skipper
  - limitations of the supply boat's performance (range or local marine regulations).

SUPPLY BOATS

Survey	Number of Supply boat	Name of the Supply boat Registration Harbour - Remarks
05	7	ARANDEL (Darwin)
10	1	ARANDEL
11	Nil	Survey operations stopped. Use of the ZODIAC rubber dinghy of the survey ship for liaisons with the shore.
12	12	2 "HARBOUR MASTER" (Lakes Entrance) 10 ARANDEL
13	4	BARBARA (Newcastle) CALYPSO II (Gladstone) SECHOMA (Yeepoon) SEA COCK (Townsville)
14	3	"TUG" (Cairns) WONGABEL (Cairns) PASADEWA STAR (Lakes Entrance)
15	5	MAY BE (St Helens) NIMITY BELL (Eden) CORAL SEA (Urangan) WENDY JOY (Ballina) PACIFIC VENTURE (Laurieton)
16	3	KAYANDEE (Currie - Tasmania) VICTORY (Fowlers Bay) ZODIAC rubber dinghy of the survey ship
17	1	"TUG" (Carnarvon) and operations stopped, survey ship went to Bunburry
18	1	ARANDEL
19	Nil	Operations stopped, survey ship went to shore (Albany)

II.3.8 - Weather (Fig. 11 - Enclosure 3)

* Generally, working areas were chosen taking into consideration the seasonal variations of the climate of Australia.

* The main features of the Australian climate are :

- A latitudinal shift in the axes of the subtropical high pressure systems and a change in the paths of the migratory anticyclones. The mean path of these systems lies over Southern Australia during the summer but moves northwards during the winter with the thermal equator. The movement is only of a few degrees. This typical configuration is shown in Fig. 11.

- Tropical cyclones on the Queensland coast, from December to April. They normally form in the Coral Sea, moving south-west close to the coast and then passing away to the south-east into the Pacific. A typical configuration is shown in Fig. 11.

* The main changes in the operations due to weather considerations were :

- The decision to start surveying in Tasmania after the TPNG survey was completed.

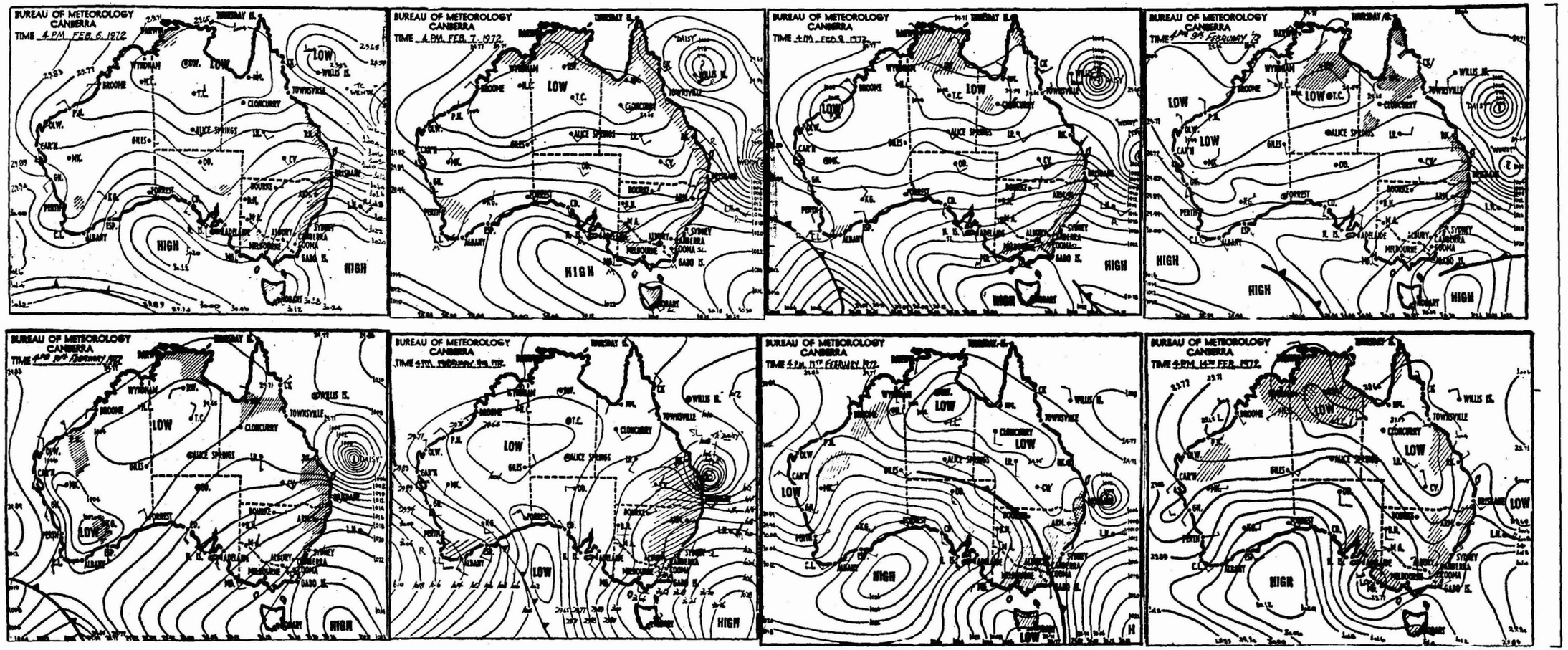
- The decision to stop surveying the Tasman area at 46° South.

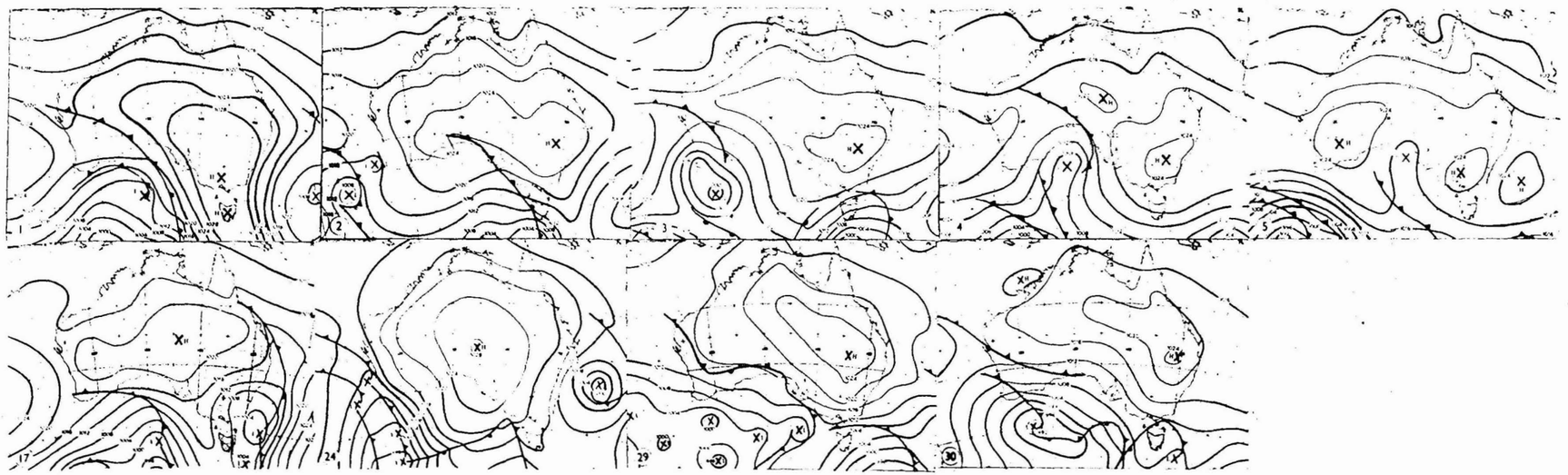
- The decision to leave the Great Australian Bight in the middle of survey 17 to start surveying the West Coast of Australia in order to follow the above mentioned latitudinal shift.

* The main problem associated with weather conditions was encountered when the cyclone "Daisy" (see Fig. 11) hit Brisbane, thus stopping the survey operations for 10 days (survey 15, end of cruise 2 and call in Brisbane).

* Weather histograms for each survey are given in fig. 12.

FIG. 11





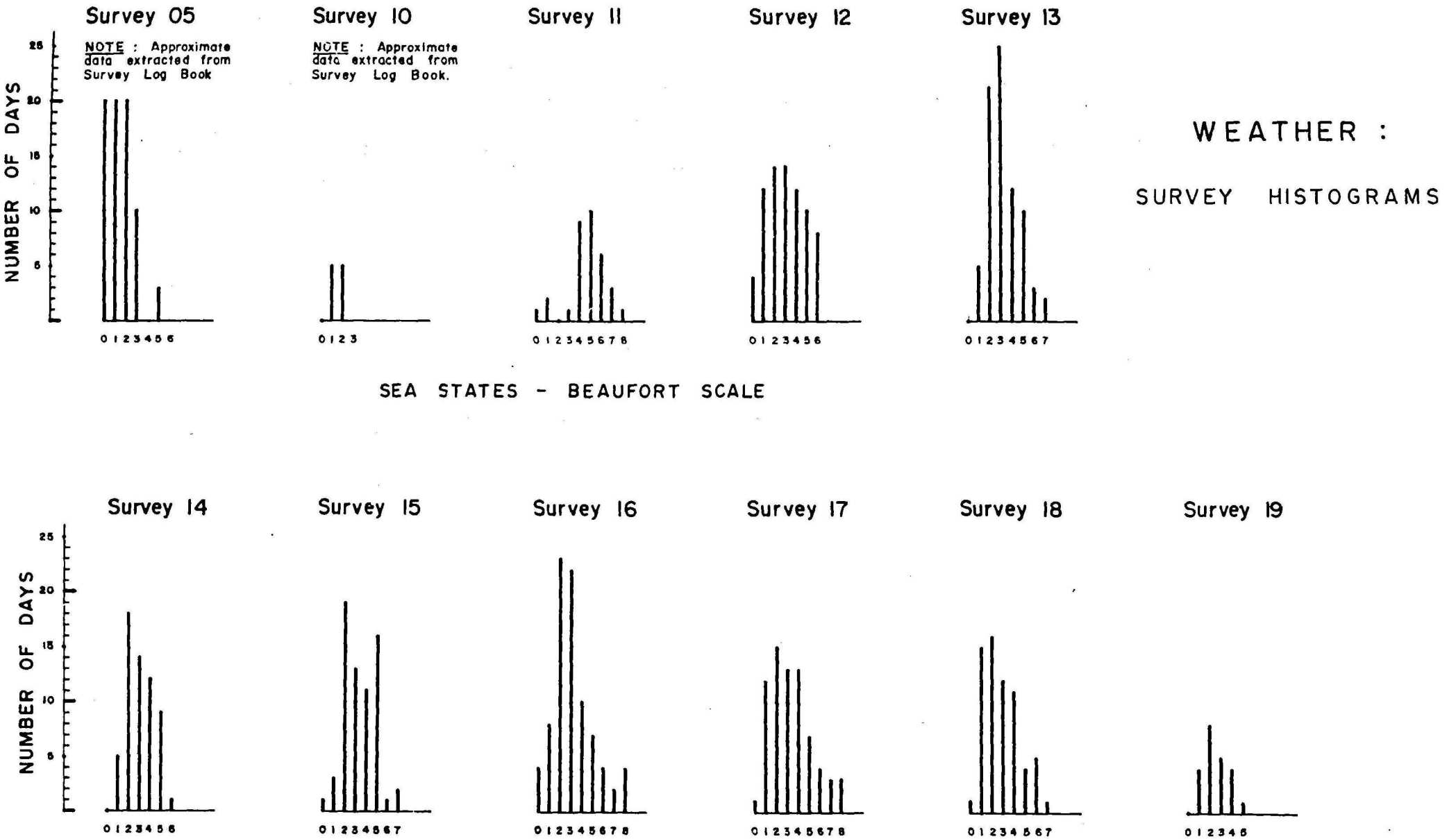
AUSTRALIAN WEATHER

SIMPLIFIED

Upper and lower figures show the latitudinal shift in the axis of the subtropical high pressure systems. The upper figures show the formation and the movements of the tropical cyclone "DAISY".

FEBRUARY 1972

JULY 1971



WEATHER :

SURVEY HISTOGRAMS

Fig. 12

* Enclosure n° 3 gives detailed weather report for each survey, compared with the duration of the working time of the same day. (Each abscissa axis is graduated in BMR days from 0 to 100 for each survey). The center of the figure provides the histogram of sea-state (in Beaufort scale) for the whole survey.

III - OPERATIONS

In this chapter, time data are given in two ways : calendar days and survey days. For instance 05.11.10.00 should be read : survey 05 day 11 at 10.00 G.M.T. Sometimes the first two digits are not written. Appendix 1 gives the correspondence between calendar days and survey days.

III.1 - PRIOR TO SURVEY 05

1 - The equipment installed on board the M/V Hamme in Sydney, was tested at sea during the voyage to Port Moresby from 15th to 26th August, 1970. Meanwhile, the Data Acquisition Programme, MISER, was modified as follows :

- addition of ten channels, digitized from analogue, i.e. 8 V.L.F. amplitudes, the sine and cosine of the heading : 32 channels were now recorded (Fig. 7).

- ability, at any time, to calibrate the 20 channels originated in analogue form.

- maintenance via the computer of three systems of dead reckoning between times of satellite fixes.

During the voyage, gravity ties were carried out in Mackay and Cairns.

2 - Test cruise in the Gulf of Papua : the test was undertaken near the Fly River delta from August 30th to September 2nd. It was shortened by the breakage of the two seismic cables which occurred during the night of August 31st/September 1st. Only one of them was found : the long cable. The decision was then taken to replace the Geotech cable by a 50 m active section taken from CGG's main cable spares.

The Chernikeeff Log was also damaged during the night.

III.2 - SURVEY 05 (Fig. 1)

Survey 05 is the Marine Geophysical Survey of the Gulf of Papua and the Bismarck Sea. It consisted of five cruises, the geographical limits of which are as follows :

	North	South	East	West
Cruise 1	02°30 S	11°20 S	152°00 E	145°40 E
Cruise 2	00°30 S	07°00 S	148°20 E	141°10 E
Cruise 3	00°40 S	05°00 S	155°00 E	144°10 E
Cruise 4	03°40 S	11°40 S	154°30 E	147°05 E
Cruise 5	08°00 S	11°30 S	147°30 E	144°00 E

The shore station (magnetism and V.L.F.) was set up in Port-Moresby.

* Cruise 1

The M/V Hamme left Port-Moresby on September 4th, 1970 at 10.00 L.T. The working period was as follows :

From 01 04 40 to 12 04 10 : End of cruise.

The ship berthed in Madang (September 15th, 1970). During this call a pair of reinforced booms (maintaining the electrodes) was installed to replace the former booms which had collapsed during cruise 1.

The ship left Madang on September 18th and went to Lae where she arrived on September 19th to collect additional supplies.

* Cruise 2

The M/V Hamme left Lae on September 21st, 1970. The working periods were as follows :

From 18 07 40 to 25 21 20 : stoppage due to general power supply failure.

From 26 04 30 to 33 07 10 : End of cruise.

During cruise 2, the magnetometer winch was installed in the Flexotir Faraday cage (Fig. 7). This completely eliminated radio interference, but not Sparker interference.

The ship berthed in Madang on October 7th, 1970. During this call, the Sparker electrode system was modified : light electrodes were installed and a better trimming of the gears was obtained.

* Cruise 3

The M/V Hamme left Madang on October 9th, 1970. The working periods were as follows :

From 37 16 20 to 53 19 35 : End of cruise.

During cruise 3, a new Chernikeeff shaft impeller was installed to replace the one damaged during the test cruise. Due to a manufacturing defect in the nylon-reflex section, the main cable was lost at the beginning of cruise 3. However, it was recovered and, after repair of the depth controllers and removal of the manometers which had been damaged due to deep immersion, operations resumed with only one manometer.

The ship berthed in Rabaul on October 27th, 1970.

* Cruise 4

The M/V Hamme left Rabaul on October 31st, 1970. The working periods were as follows :

From 58 18 00 to 62 20 20 : stoppage due to a failure of the Data Acquisition System. Brief Port of call in Lae to meet a Hewlett Packard technician.

From 64 11 40 to 72 11 20 : End of cruise 4.

During this cruise, all the improvements made in the electrode system meant that maintenance time was zero : the time lost for electrode maintenance was 2 hours every day during cruise 1, 1.5 hours per day during cruise 2 and 15 minutes per day during cruise 3. During cruise 4, the electrodes were put into the sea when leaving Lae and gave no trouble until the vessel arrived in Port Moresby.

Following a test refraction probe, the refraction operating techniques were changed as follows :

- Speed of the ship : 6 knots
- Shot interval : 10 seconds
- Recording by the Aquatronics receiver, external filters (HP 200 x 1000, LP 40 x 1, on band reject), the graphic recorder (filters by passed, if they exist)
- Abandonning of Flexotir as a refraction source
- Shifting the aerial to the top of the rear mast.

The ship berthed in Port Moresby on November 15th, 1970. During this call, the following equipment changes were carried out :

- Navigation clock, Sagem interface, potentiometer Sin - Cos and operational amplifiers were changed to 60 Hz operation ; Ni , Cd batteries were also added to the navigation clock.
- Elac Sounder and Chernikeeff Log : a special relay was installed to change automatically from one converter to the other in the event of a converter failure.
- A new seismic cab was installed.
- Three manometers were attached to the main cable.
- Two new pieces of equipment arrived on board and were made operational during cruise 5 : a seismic graphic recorder (Raytheon) and a depth digitizing system (Digitrack).

* Cruise 5

The M/V Hamme left Port Moresby on November 23rd, 1970. The working period was as follows :

From 81 12 00 to 95 14 00 : End of cruise 5.

The ship berthed in Port Moresby on December 7th, 1970. Cruise 5 ended the Marine Geophysical Survey of the Gulf of Papua and the Bismarck Sea.

III.3 - * MARINE GEOPHYSICAL SURVEY OF THE CONTINENTAL SHELF OF AUSTRALIA

It consisted of ten surveys numbered 10 to 19 which are now described.

III.3.1 - Survey 10 (Fig. 13)

The M/V Hamme left Port Moresby on December 12th, 1970. The working periods were as follows :

From 01 13 10 to 03 11 50 : travelling to next line.

From 03 19 30 to 09 20 30 : End of survey 10.

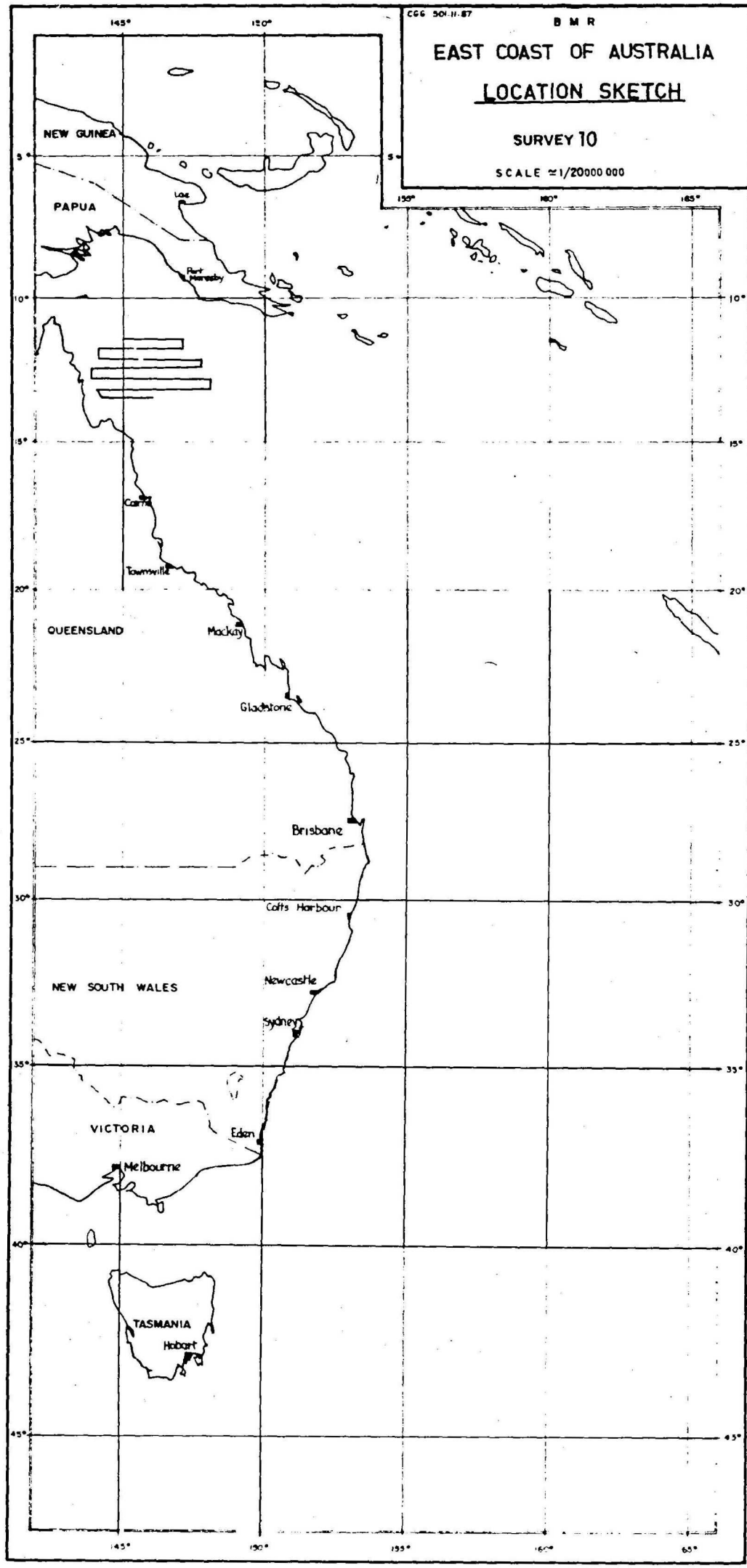
The ship berthed in Cairns 23rd December 1970.

III.3.2 - Repositioning of the ship in Tasmania

The M/V Hamme left Cairns on December 25th, 1970 ; she arrived in Hobart (Tasmania) on January 3rd, 1971.

During this trip, a modification was made in the Data Acquisition Programme Miser ; its aim was to eliminate the Sparker interference with the magnetic data.

Fig. 13


CGG 501-11-87
B M R
EAST COAST OF AUSTRALIA
LOCATION SKETCH
SURVEY 10
SCALE ≈ 1/20000 000
NEW GUINEA
PAPUA
Port Moresby
QUEENSLAND
Cairns
Townsville
Mackay
Gladstone
Brisbane
Coffs Harbour
NEW SOUTH WALES
Newcastle
Sydney
VICTORIA
Eden
Melbourne
TASMANIA
Hobart
145°
150°
155°
160°
165°
5°
10°
15°
20°
25°
30°
35°
40°
45°

A new seismic amplifier was installed (AS 626 X).

The main cable was overhauled.

III.3.3 - Test cruises

Prior to starting survey 11, test cruises were made and all the equipment was given a complete overhaul.

Test cruise 1 : from January 10th to January 14th, 1971, from Hobart to Hobart.

Test cruise 2 : from January 20th to January 24th, 1971, from Hobart to Hobart.

Travelling to Melbourne : from January 25th to January 27th ; for the installation of a new Atlas 30 Kc transducer, no dry dock being available in Hobart.

Repositioning in Hobart : from January 30th to February 2nd. during this trip, tests were carried out by a technician on the gyro-compass and the auto-pilot.

Test cruise 3 : from February 4th to February 7th, from Hobart to Hobart.

During the period from January 3 rd to February 16th (start of survey 11), some new equipment was put on board the ship ; it consisted of :

- two Geotech cables
- a graphic camera in the seismic room
- an automatic reader for the Data Acquisition System.

At the shore station, the Sud Aviation magnetometer and the Servogor recorder were replaced by a complete Varian System.

III.3.4 - Survey 11 (Fig. 14)

It consisted of two cruises in the area covering South Tasmania. Its geographical limits were as follows :

	North	South	East	West
Cruises 1 and 2	42°50'S	46°10'S	151°30'E	143°30'E

The shore station (V.L.F. and Magnetism) was set up in Hobart (Fig. 3).

Cruise 1

The M/V Hamme left Hobart on February 16th. The working periods were as follows :

From 01 18 10 to 03 07 15 : short call in Hobart to disembark a Lacoste and Romberg technician.

From 04 14 50 to 06 18 45 : stoppage for bad weather.

From 09 04 40 to 14 05 40 : stoppage for bad weather.

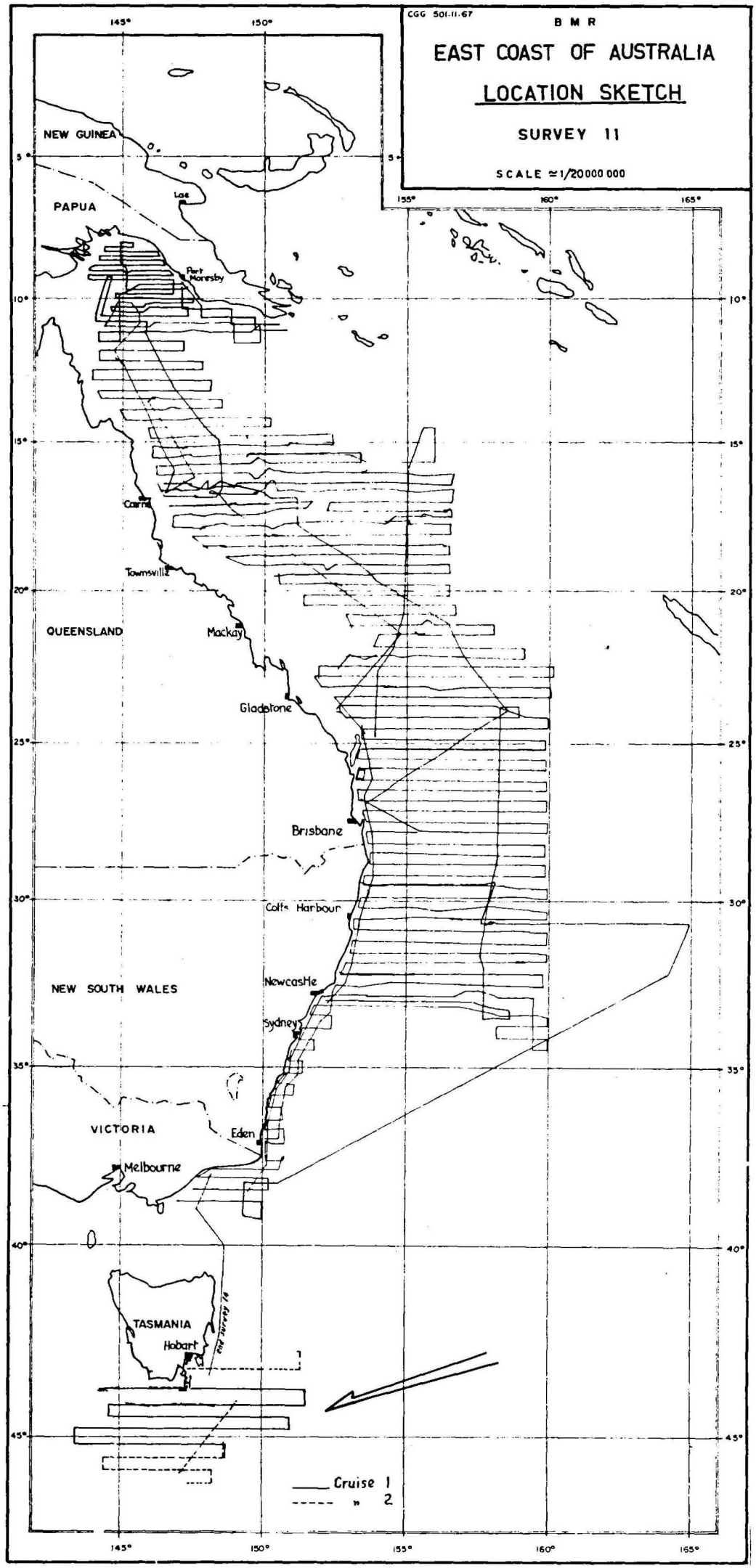
The M/V Hamme entered Hobart on March 2nd, 1971.

Cruise 2

The M/V Hamme left Hobart on March 4th. The working periods were as follows :

From 18 04 30 to 18 08 20 : travelling to next line.
From 18 18 00 to 19 00 20 : travelling to next line.
From 19 06 00 to 19 15 10 : travelling to next line.
From 20 04 00 to 20 16 10 : travelling to next line.
From 21 09 00 to 23 23 30 : stoppage for bad weather.
From 31 17 10 to 32 11 40 : stoppage for bad weather.
From 33 22 00 to 35 00 30 : end of cruise.

Fig.14


CGG 501-11-67
B M R
EAST COAST OF AUSTRALIA
LOCATION SKETCH
SURVEY 11
SCALE ≃1/20000 000
NEW GUINEA
PAPUA
Lae
Port Moresby
Cairns
Townsville
QUEENSLAND
Mackay
Gladstone
Brisbane
Coffs Harbour
NEW SOUTH WALES
Newcastle
Sydney
VICTORIA
Eden
Melbourne
TASMANIA
Hobart
Cruise 1
" 2
145°
150°
155°
160°
165°
5°
10°
15°
20°
25°
30°
35°
40°
45°

Working periods 1, 2, 3, 4 and the beginning of period 5 were concerned with re-surveying of lines of cruise 1. Re-surveys 1, 2, 3, 4 were carried out without seismic and magnetic recordings.

The ship berthed in Hobart March 23rd, 1971. Cruise 2 ended survey 11.

III.3.5 - Survey 12 (Fig. 15)

Before starting survey 12, the ship was dry docked in Melbourne in order to carry out reclassification work.

Survey 12 consisted of four cruises on the South East Coast of Australia. Its geographical limits were as follows :

	North	South	East	West
Cruise 1	32°30'S	39° S	160° E	147° E
Cruise 2	31° S	37° S	150° E	160° E
Cruise 3	27° S	31° S	153° E	160° E
Cruise 4	25° S	28° S	153° E	160° E

The shore-station (V.L.F. and magnetism) was set up at Eden (cruise 1), then at Coffs Harbour (cruises 2, 3 and 4) (Fig. 3).

Cruise 1

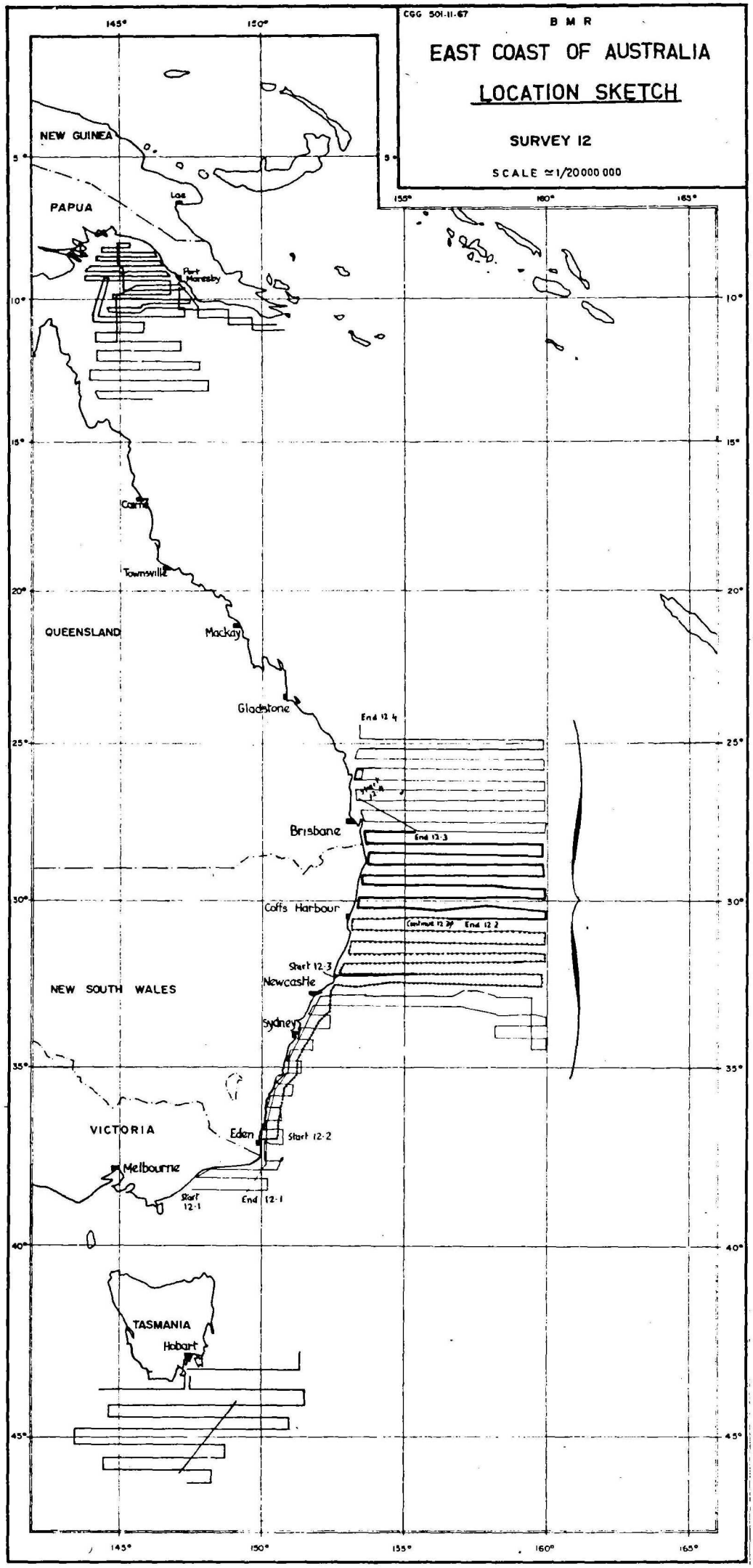
The M/V Hamme left Melbourne on April 5th, 1971. The working periods were as follows :

From 01 18 10 to 12 04 40 : stoppage for bad weather.
From 12 08 40 to 13 15 20 : stoppage for bad weather.
From 14 01 50 to 16 06 00 : end of cruise 1.

During this cruise, a new graphic recorder (EPC Model 4100) was installed in the seismic room.

The ship berthed in Eden on April 22nd, 1971.

Fig. 15


CGG 501-11-67
B M R
EAST COAST OF AUSTRALIA
LOCATION SKETCH
SURVEY 12
SCALE ≃1/20000 000
NEW GUINEA
PAPUA
Port Moresby
Cairns
Townsville
QUEENSLAND
Mackay
Gladstone
Brisbane
Coffs Harbour
NEW SOUTH WALES
Newcastle
Sydney
VICTORIA
Eden
Melbourne
TASMANIA
Hobart
End 12·4
End 12·3
End 12·2
Start 12·3
Start 12·2
Start 12·1
End 12·1
145°
150°
155°
160°
165°
5°
10°
15°
20°
25°
30°
35°
40°
45°

Cruise 2

The M/V Hamme left Eden on April 25th, 1971. The working periods were as follows :

From 20 04 20 to 25 17 45 : stoppage for gravitymeter failure. Short call in Newcastle for recalibration of the system.

From 28 00 50 to 29 14 50 : stoppage for bad weather.

From 31 11 55 to 31 22 45 : stoppage for Sparker system failure.

From 32 12 50 to 38 20 10 : end of cruise.

During this cruise, two new EPC graphic recorders were installed in the seismic room.

The ship berthed in Newcastle on May 17th, 1971.

Cruise 3

The M/V Hamme left Newcastle on May 20th, 1971. The working periods were as follows :

From 45 21 00 to 46 12 30 : stoppage for bad weather.
From 47 04 10 to 60 06 40 : end of cruise 3.

The ship berthed in Brisbane on June 7th, 1971.

Cruise 4

The M/V Hamme left Brisbane on June 10th, 1971. The working periods were as follows :

From 66 15 00 to 84 01 30 : end of cruise 4.

The ship berthed in Gladstone on June 27th, 1971. Cruise 4 ended survey 12.

III.3.6 - Survey 13 (Fig. 16)

It consisted of five cruises covering the East Coast of Australia. Its geographical limits were as follows :

	North	South	East	West
Cruise 1	24° S	33°30'S	160° E	152°30'E
Cruise 2	22°30'S	24°30'S	160° E	152° E
Cruise 3	19°30'S	22°30'S	159° E	150°30'E
Cruise 4	17°30'S	19°30'S	157° E	147°30'E
Cruise 5	16°30'S	24° S	157° E	147° E

The shore station (V.L.F. and Magnetism) was set up at Coffs Harbour (days 01 to 15), then at Mackay (days 19 to 97) (Fig. 3).

Cruise 1

The M/V Hamme left Gladstone on July 2nd, 1971. The working periods were as follows :

From 01 17 20 to 03 06 00 : stoppage due to the loss of the main cable ; it was retrieved, then refitted and operations resumed again.

From 03 16 50 to 04 16 20 : stoppage due to supply boat.

From 04 20 00 to 15 07 20 : end of cruise 1.

The ship berthed at Brisbane on July 17th, 1971.

Cruise 2

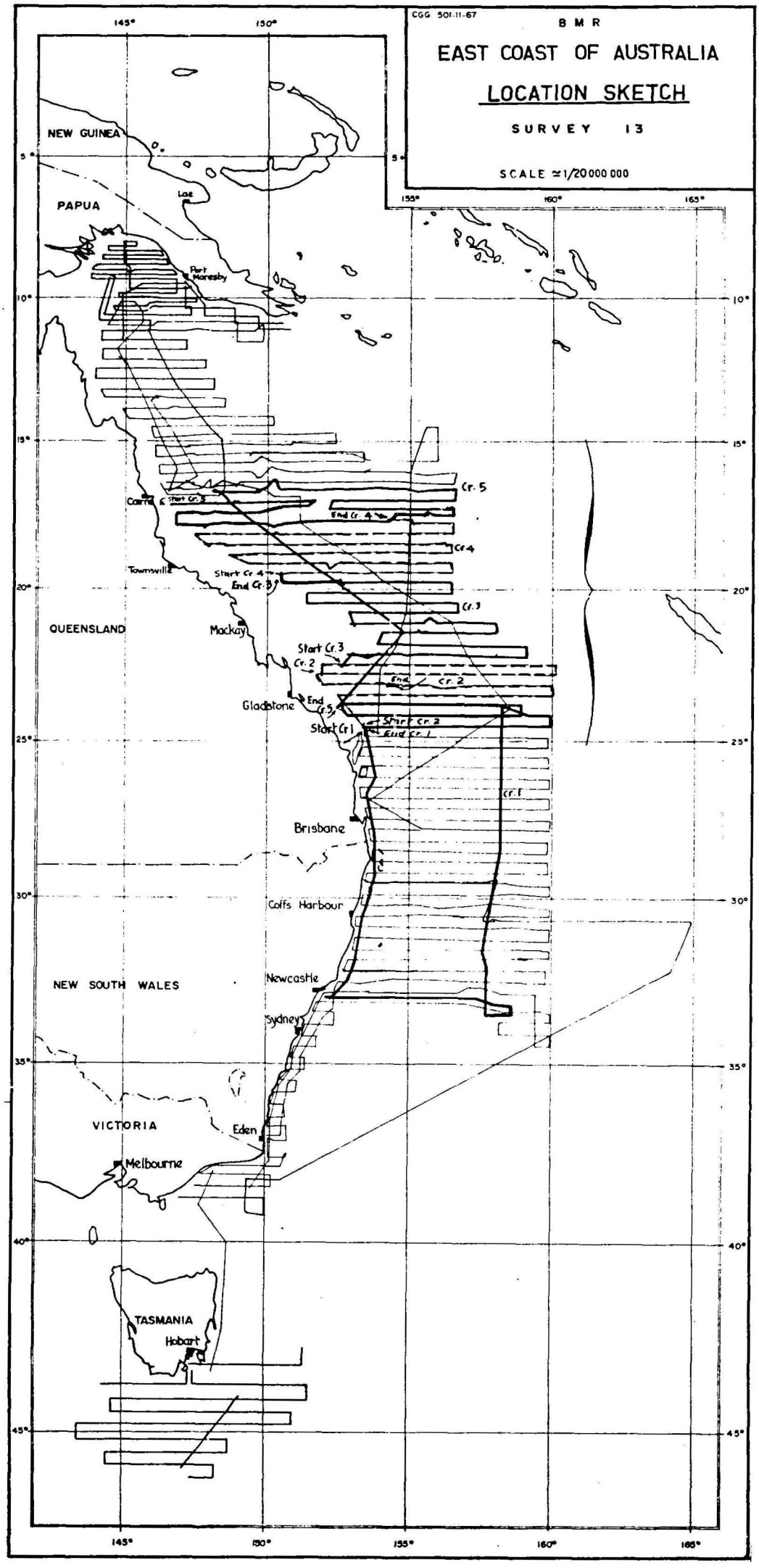
The M/V Hamme left Brisbane on July 20th, 1971. The working periods were as follows :

From 19 18 10 to 23 18 10 : stoppage due to bad weather.

From 23.22.00 to 23 23 00 : stoppage due to Sparker system breakdown.

From 25 01 10 to 29 00 00 : end of cruise.

Fig. 16


CGG 501-11-67
B M R
EAST COAST OF AUSTRALIA
LOCATION SKETCH
SURVEY 13
SCALE ≃1/20 000 000
NEW GUINEA
PAPUA
Port Moresby
QUEENSLAND
Townsville
Mackay
Gladstone
Brisbane
Coffs Harbour
NEW SOUTH WALES
Newcastle
Sydney
VICTORIA
Eden
Melbourne
TASMANIA
Hobart
Cr. 5
Cr 4
Cr. 3
Cr. 2
Cr. 1
Start Cr. 3
End Cr. 4
Start Cr 4
End Cr. 3
Start Cr. 2
End Cr. 1
145°
150°
155°
160°
165°
5°
10°
15°
20°
25°
30°
35°
40°
45°

The M/V Hamme berthed at Brisbane on August 1st, 1971. During this call, M/V Hamme's flag was changed and the vessel was christened M/V Lady Christine.

Cruise 3

The M/V Lady Christine left Brisbane on August 6th, 1971. The working periods were as follows :

From 38 01 50 to 38 11 30 : stoppage due to a failure of the Navigation Satellite System ; short call in Gladstone for repairs.

From 41 13 40 to 44 22 10 : stoppage due to a failure of the gravitymeter.

From 45 01 30 to 47 03 00 : stoppage due to supply boat.

From 48 21 20 to 54 02 40 : stoppage due to the main cable.

From 54 17 40 to 55 11 10 : end of cruise 3.

M/V Lady Christine berthed at Townsville on August 26th, 1971. During this call, a new tape recorder (Hewlett Packard 7979 A) was installed in the navigation room to replace the HP 2020 B recorder of the Data Acquisition System.

Cruise 4

The M/V Lady Christine left Townsville on August 29th, 1971. The working periods were as follows :

From 60 19 50 to 66 12 40 : stoppage due to the main cable.

From 67 02 30 to 69 01 30 : stoppage due to main power failure.

From 69 08 30 to 69 14 00 : stoppage due to supply boat.

From 69 21 40 to 70 22 30 : stoppage due to Sparker System failure.

From 71 03 20 to 73 05 20 : stoppage due to the main cable.

From 73 08 50 to 73 15 00 : end of cruise 4.

The ship berthed at Cairns on September 18th, 1971.

Cruise 5

The M/V Lady Christine left Cairns on September 20th, 1971. The working periods were as follows :

From 82 13 10 to 83 04 20 : stoppage due to the main cable.

From 83 17 20 to 86 02 20 : stoppage due to the main cable.

From 86 11 50 to 88 13 00 : stoppage due to Sparker System failure.

From 88 15 50 to 89 01 20 : stoppage due to the main cable.

From 89 06 00 to 93 14 20 : stoppage due to entanglement of the cables.

From 94 14 30 to 97 21 20 : end of cruise 5.

The ship berthed at Brisbane on October 8th, 1971. Cruise 5 ended survey 13.

III.3.7 - Survey 14 (Fig. 17)

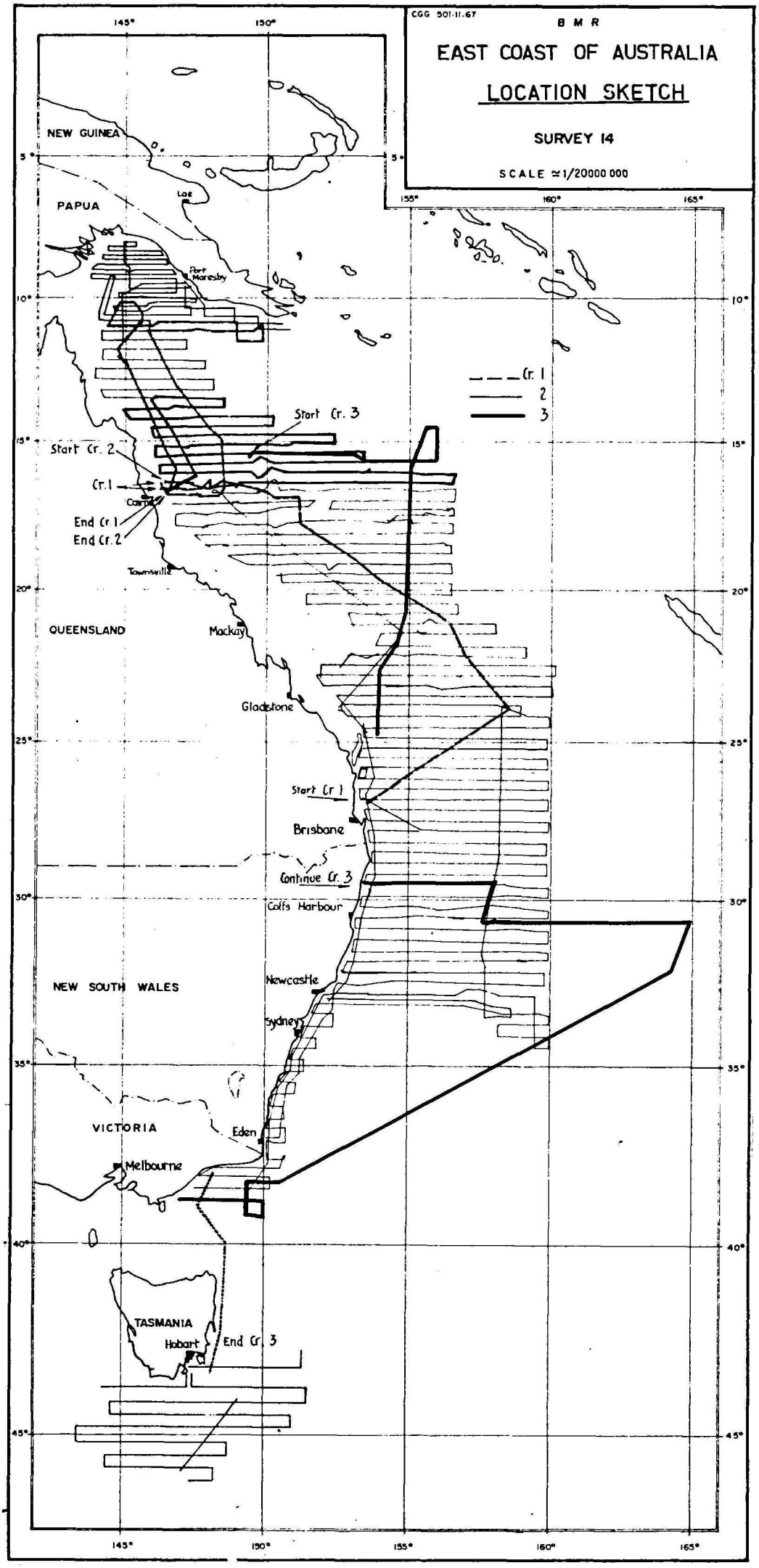
During the call in Brisbane, prior to the start of survey 14, important alterations to the equipment were completed :

- Installation, in dry dock, of a Raytheon transducer, part of a new bathymetric system.
- Installation of an EPC graphic recorder for the recording of the Raytheon system.
- Unloading of the equipment constituent of the Marine Seismic Processing System.
- Installation in the seismic room of a fourth EPC graphic recorder.
- Installation of a spare 15 kVA, 220 V, 60 Hz generator.

Finally, installation in Brisbane of a streamer workshop.

Survey 14 consisted of three cruises covering the East Coasts of Australia and Tasmania. Its geographical limits are as follows :

Fig. 17


CGG 501-11-67
B M R
EAST COAST OF AUSTRALIA
LOCATION SKETCH
SURVEY 14
SCALE ≈1/20000 000
NEW GUINEA
PAPUA
Lae
Port Moresby
Cr. 1
2
3
Start Cr. 3
Start Cr. 2
Cr. 1
Cairns
End Cr 1
End Cr. 2
Townsville
QUEENSLAND
Mackay
Gladstone
Start Cr 1
Brisbane
Continue Cr. 3
Coffs Harbour
NEW SOUTH WALES
Newcastle
Sydney
VICTORIA
Eden
Melbourne
TASMANIA
Hobart
End Cr. 3
145°
150°
155°
160°
165°
5°
10°
15°
20°
25°
30°
35°
40°
45°

	North	South	East	West
Cruise 1	10° S	27° S	158° E	144° E
Cruise 2	14° S	17° S	157° E	145° E
Cruise 3	14° S	43° S	165° E	147° E

The shore station was set up at Mackay (cruise 1) and then at Cairns (cruise 2 and 3).

Cruise 1

The M/V Lady Christine left Brisbane on October 13th, 1971. The working periods were as follows :

From 06 12 10 to 06 23 30 : stoppage due to excessive noise on the main cable.

From 07 05 40 to 12 09 30 : short call in Cairns to bring spare parts for the magnetometer on board.

From 13 15 50 to 14 00 00 : stoppage due to main cable difficulties.

From 14 02 20 to 20 03 00 : stoppage due to main cable difficulties.

From 20 12 20 to 21 22 00 : end of cruise 1.

The ship berthed at Cairns on November 1st, 1971. During this call, the decision was made to do away with the V.L.F. shore station recording and to transfer the corresponding equipment to the M/V Lady Christine.

Cruise 2

The ship left Cairns on November 5th. The working periods were as follows :

From 28 15 00 to 28 21 40 : navigation clock and seismic system difficulties.

From 29 09 30 to 30 00 00 : Sparker difficulties.

From 30 04 40 to 33 02 10 : Sparker and main cable difficulties.

From 33 20 30 to 40 03 20 : electrodes maintenance.

From 40 05 30 to 41 04 40 : Sparker tests.

From 41 11 10 to 48 23 00 : end of cruise.

The M/V Lady Christine berthed at Cairns on November 26th, 1971. During this call, 12 traces built in the streamer workshop were brought on board the ship.

Cruise 3

The ship left Cairns on November 29th, 1971 ; the working periods were as follows :

From 53 23 20 to 59 00 40 : short call in Brisbane to bring back on board the streamer workshop and another brief call in Coffs Harbour to change the crew of the Lady Christine.

From 64 15 50 to 66 07 00 : stoppage due to the main cable.

From 66 10 30 to 73 09 30 : stoppage due to supply boat.

From 74 20 40 to 76 06 50 : end of cruise 4.

The ship berthed at Hobart on December 24th, 1971. Cruise 3 ended survey 14.

III.3.8 - Survey 15 (Fig. 18)

It consisted of 4 cruises ; its geographical limits were :

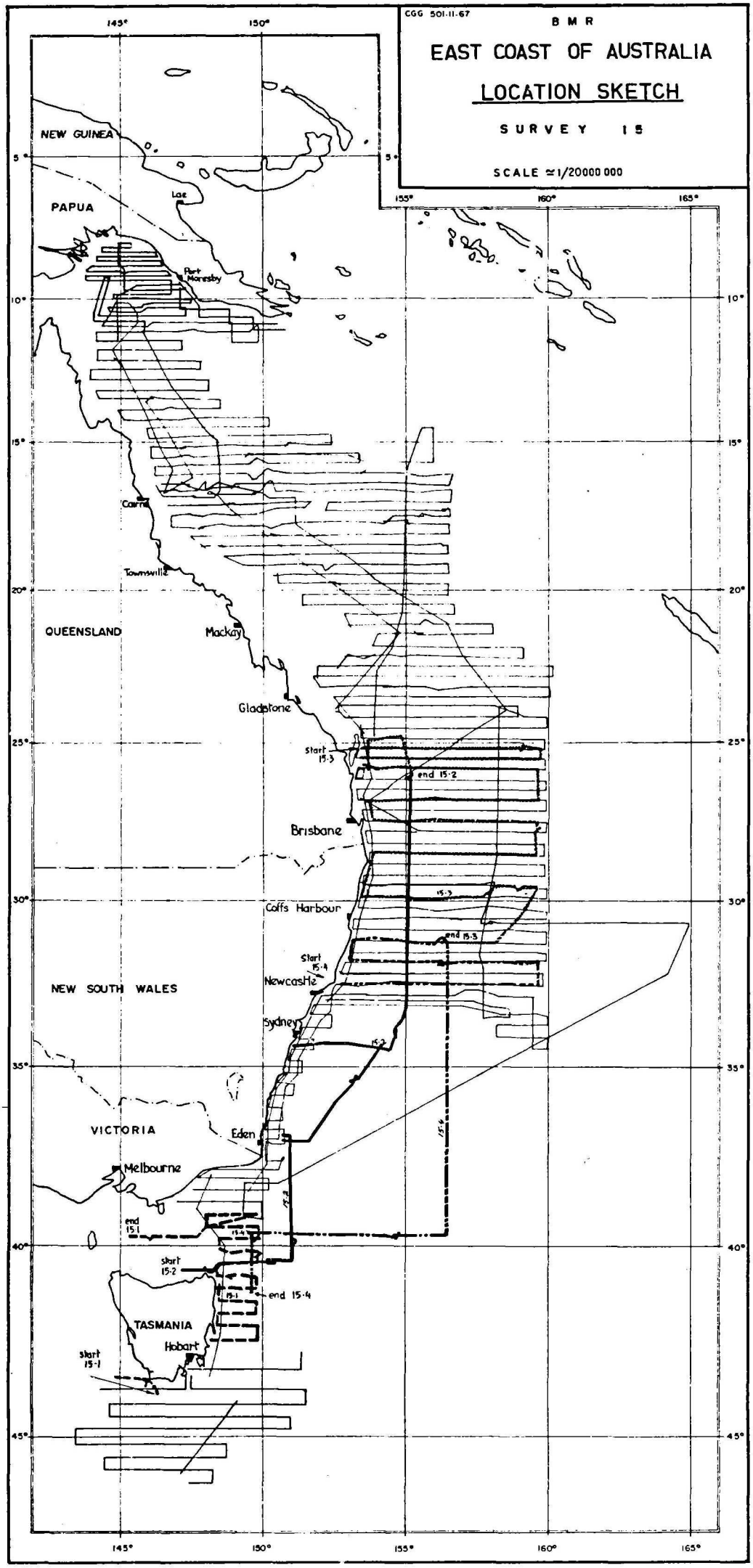
North	South	East	West
26° S	44° S	144° E	157° E

The shore station was set up at Launceston, and later at Evandale. It only recorded when the ship was in the vicinity of the Tasmanian coast.

Cruise 1

The M/V Lady Christine left Hobart on December 28th, 1971 ; the working periods were as follows :

Fig. 18


CGG 501-11-67
B M R
EAST COAST OF AUSTRALIA
LOCATION SKETCH
SURVEY 15
SCALE ≃1/20000 000
NEW GUINEA
PAPUA
Lae
Port Moresby
Cairns
Townsville
QUEENSLAND
Mackay
Gladstone
Brisbane
Coffs Harbour
NEW SOUTH WALES
Newcastle
Sydney
VICTORIA
Eden
Melbourne
TASMANIA
Hobart
start 15-3
end 15-2
15-3
end 15-3
start 15-4
15-2
15-6
end 15-1
start 15-2
15-1
end 15-4
start 15-1
145°
150°
155°
160°
165°
5°
10°
15°
20°
25°
30°
35°
40°
45°

From 02 04 10 to 02 09 20 : stoppage due to bad weather.

From 03 01 30 to 03 09 20 : stoppage due to the loss of the main cable ; as it was not retrieved, it was decided to resume the operations with a provisional 3 channel cable, the speed of the ship being 6 knots.

From 06 21 50 to 09 03 20 : stoppage due to a supply boat.

From 09 09 10 to 10 06 20 : stoppage due to a gravitymeter failure.

From 10 10 50 to 11 07 00 : stoppage due to a general power failure.

From 11 13 30 to 12 15 20 : stoppage due to Sparker system failure.

From 12 20 10 to 15 09 35 : stoppage due to Sparker system failure.

From 15 16 20 to 15 23 20 : end of cruise 1 due to bad weather.

The ship berthed at Launceston on January 13th, 1972. During this call, a new seismic cable was fitted with new elements air freighted from France.

The Lacoste Romberg gravitymeter was unloaded and sent to Austin (U.S.A.) to be checked.

A change in the programme was decided upon : operations in the Great Australian Bight were delayed in order to carry out complementary work on the East Coast of Australia.

Cruise 2

The M/V Lady Christine left Launceston on January 20th, 1972. The working periods were as follows :

From 24 17 00 to 24 21 40 : stoppage due to excessive noise on the main cable.

From 25 03 00 to 25 13 00 : stoppage due to preparation of the seismic equipment for test.

From 25 18 30 to 27 13 30 : stoppage due to supply boat.

From 28 05 20 to 29 03 10 : stoppage due to main cable difficulties.

From 29 07 00 to 29 18 40 : stoppage due to bad weather.

From 31 02 00 to 31 22 40 : stoppage due to Sparker system failure.

From 32 04 00 to 34 09 10 : end of cruise 2 due to bad weather.

The ship berthed at Brisbane on February 6th, 1972.

Cruise 3

The departure from the harbour was delayed by weather conditions. The M/V Lady Christine left Brisbane on February 14th, 1972. The working periods were as follows :

From 50 10 10 to 51 21 10 : stoppage due to Sparker system failure.

From 51 23 50 to 53 23 50 : stoppage due to one Sparker generator. Sail to Brisbane for repair.

From 57 11 40 to 58 10 10 : stoppage due to the main cable.

From 59 12 20 to 65 01 10 : stoppage due to the main cable.

From 65 06 10 to 69 22 00 : stoppage due to the loss of the main cable. Unsuccessful attempts were made to retrieve it.

The ship berthed at Newcastle on March 7th, 1972. During this call, the streamer workshop was installed and a new seismic cable was refitted.

The Lacoste Romberg gravitymeter returned from Austin (U.S.A.) and was reinstalled on the ship.

Cruise 4

The ship left Newcastle on March 12th, 1972. The working periods were as follows :

From 77 09 10 to 80 02 30 : stoppage due to main cable leakages.

From 80 10 30 to 85 04 00 : stoppage due to main cable leakages.

From 85 07 40 to 86 24 00 : end of cruise due to bad weather.

The Lady Christine berthed at Launceston on March 26th, 1972. Cruise 4 ended survey 15.

III.3.9 - Survey 16 (Fig. 19)

It consisted of four cruises covering the West Coast of Tasmania and the Great Australian Bight. Its geographical limits were as follows :

	North	South	East	West
Cruise 1	38° S	44° S	150° E	140° E
Cruise 2	32° S	39° S	141° E	133° E
Cruise 3	31° S	37° S	138° E	130° E
Cruise 4	31° S	36° S	135° E	124° E

The shore station (magnetism) was successively set up at : (fig.

- Launceston : days 1 to 18
- Coffin Bay : days 22 to 69
- Albany : day 77 to the end of the survey.

Cruise 1

The M/V Lady Christine left Launceston on March 29th, 1972 ; the working periods were as follows :

From 02 08 00 to 03 16 40 : stoppage in order to travel to West Tasmanian Coast.

From 04 18 10 to 13 06 30 : stoppage due to Sparker system failure (electrodes).

From 13 09 20 to 15 20 30 : stoppage due to bad weather.

From 17 04 20 to 19 01 30 : end of cruise 1.

The ship berthed at Portland on April 16th, 1972.

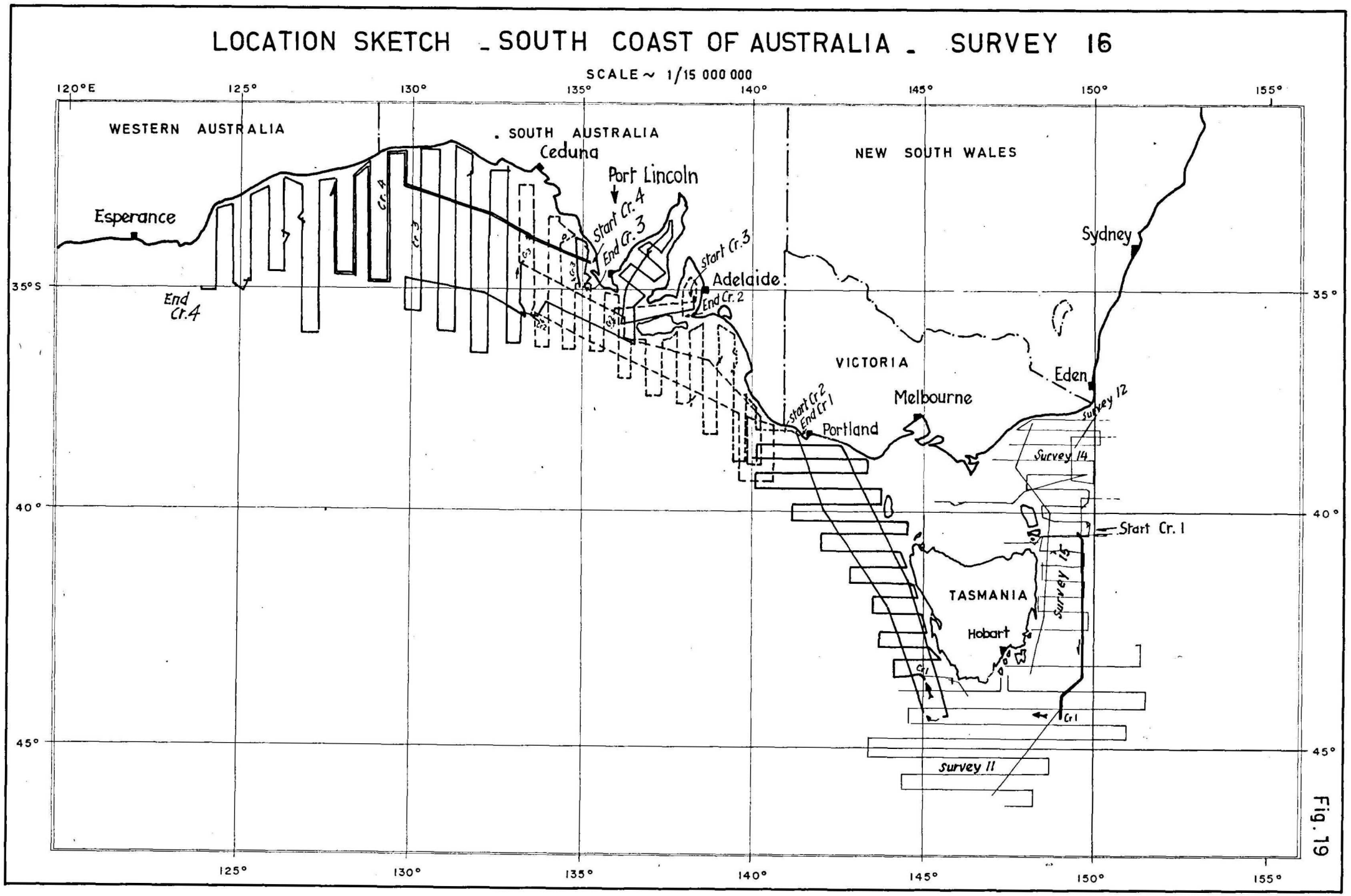

LOCATION SKETCH - SOUTH COAST OF AUSTRALIA - SURVEY 16
SCALE ~ 1/15 000 000
120°E
125°
130°
135°
140°
145°
150°
155°
35°S
40°
45°
WESTERN AUSTRALIA
SOUTH AUSTRALIA
NEW SOUTH WALES
VICTORIA
TASMANIA
Ceduna
Port Lincoln
Esperance
Adelaide
Sydney
Melbourne
Eden
Portland
Hobart
Start Cr.4
End Cr.3
Start Cr.3
End Cr.4
End Cr.2
Start Cr.2
End Cr.1
Start Cr. 1
Survey 12
Survey 14
Survey 13
Survey 11
Cr.1
Cr.2
Cr.3
Cr.4

Fig. 19

Cruise 2

The M/V Lady Christine left Portland on April 19th, 1972. The working periods were as follows :

From 22 15 00 to 23 04 10 : stoppage due to main cable difficulties.

From 23 06 00 to 24 11 00 : stoppage due to a Sparker breakdown.

From 24 14 50 to 24 18 00 : stoppage due to main cable failures.

From 24 23 10 to 25 14 30 : stoppage due to bad weather. Ship sails to Adelaïde to carry out repairs to the Sparker generator damaged by rough seas.

From 31 04 40 to 33 04 00 : stoppage due to the main cable.

From 33 10 20 to 36 00 00 : stoppage to disembark sick technician.

From 36 04 40 to 46 09 30 : travelling to next profile.

From 47 01 30 to 48 02 10 : end of cruise 2.

The ship entered Port Adelaïde on May 16th, 1972. During the call in Adelaïde on day 26, the Sparker container was altered to allow for the adaptation of an Open Air Thyratron of 200 kilojoules and to reduce the number of electrodes needed to one. Subsequently the length of the electrode was extended and the weight was doubled, in order to increase the immersion depth of the gear. This system began working on day 31.

Cruise 3

The M/V Lady Christine left Port Adelaïde on May 19th, 1972 ; the working periods were as follows :

From 52 16 20 to 53 17 30 : stoppage due to the main cable.

From 53 21 00 to 57 23 30 : stoppage due to a supply boat.

From 59 17 20 to 62 08 50 : stoppage due to main engine failure.

From 62 17 50 to 68 05 30 : travelling.

From 68 16 30 to 69 03 20 : stoppage due to a gravitymeter failure.

From 69.14 20 to 69 22 20 : end of cruise 3.

The main seismic cable was not utilized from days 53 to 55 whilst shooting was carried out in the shallower waters of Spencer Gulf ; only the Geotech cable was used, the reason being the perfect control of the immersion depth which could be achieved from the seismic container.

A new seismic amplifier, the SIE PT 700, installed during the call in Adelaïde, became operational during cruise 3.

The M/V Lady Christine entered Port Lincoln on June 6th, 1972. During this call, three new "Speedomax" graphic recorders were installed in the Navigation Room to replace the Westronics recorders.

Cruise 4

The ship left Port Lincoln on June 9th, 1972 : the working periods were as follows :

From 74 10 00 to 74 20 00 : stoppage due to a gyro-compass failure.

From 75 00 00 to 82 00 00 : stoppage due to a failure of the teletype of the Navigation Satellite System.

From 82 08 50 to 83 05 20 : stoppage due to a main engine failure.

From 83 12 50 to 85 09 00 : stoppage due to bad weather.

From 87 00 40 to 88 13 10 : end of cruise due to bad weather.

The ship entered Esperance on July 1st, 1972. Cruise 4 ended survey 16.

III.3.10 - Survey 17 (Fig. 20)

It consisted of four cruises covering the West Coast of Australia ; its geographical limits were as follows :

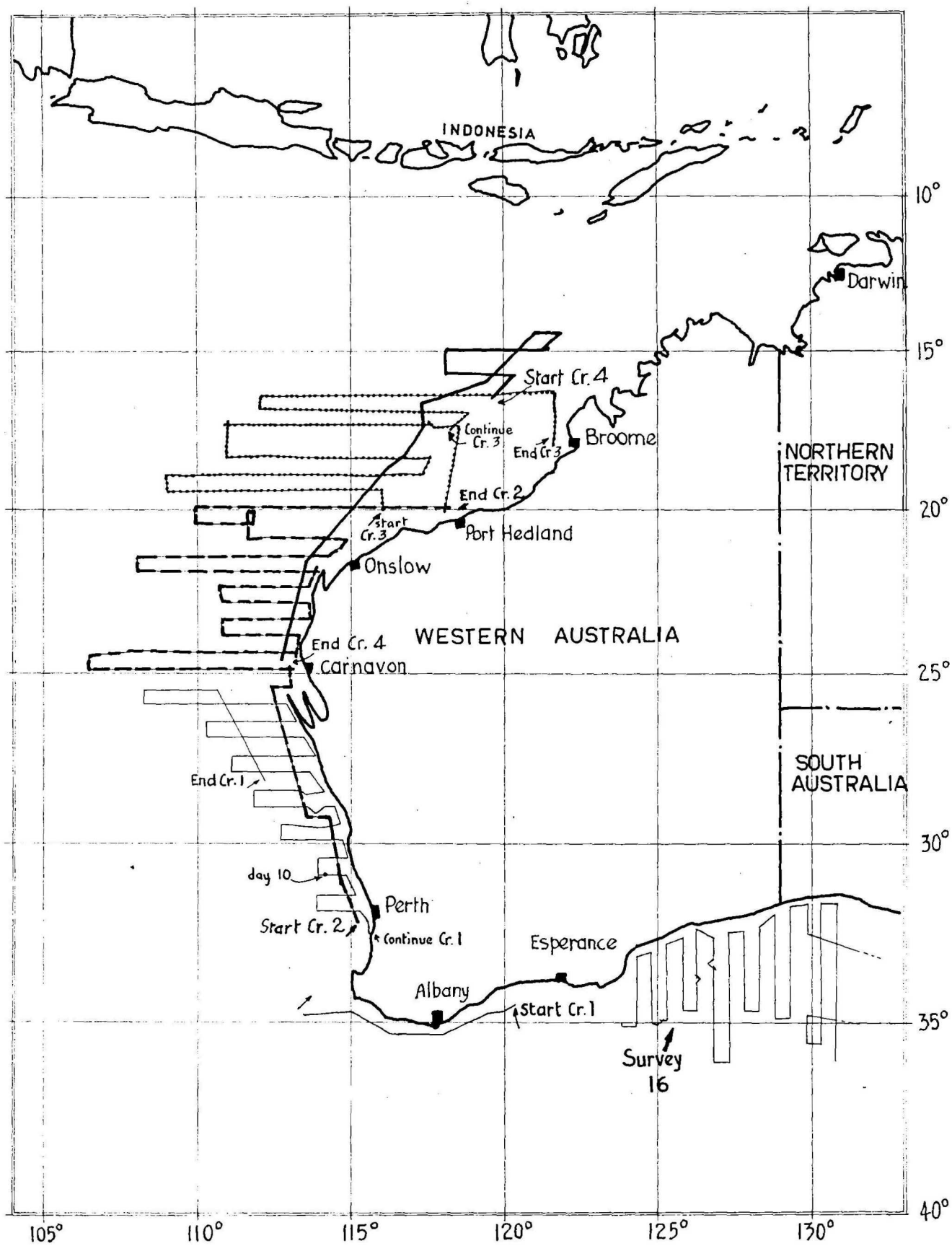
Fig. 20

LOCATION SKETCH for

SOUTH, WEST and NORTH COASTS OF AUSTRALIA

SCALE 1 / 20000000

SURVEY 17



	North	South	East	West
Cruise 1	26° S	36° S	120° E	108° E
Cruise 2	20° S	32° S	118° E	107° E
Cruise 3	16° S	20° S	122° E	109° E
Cruise 4	14° S	25° S	122° E	113° E

The shore station was set up successively at : (fig. 3)

- Albany : days 01 to 09
- Onslow : day 16 to the end of the survey.

From the beginning of survey 17, a new Data Acquisition Programme designed by the BMR, the JOY programme, replaced the MISER programme.

Cruise 1

The M/V Lady Christine left Esperance on July 4th, 1972 ; the working periods were as follows :

From 02 15 10 to 04 09 40 : stoppage due to bad weather ; short call at Bunburry.

From 08 14 20 to 20 10 00 : end of cruise 1 due to bad weather.

The ship berthed at Freemantle on July 25th, 1972.

Cruise 2

The M/V Lady Christine left Freemantle on July 27th, 1972 ; the working periods were as follows :

From 25 19 20 to 26 07 00 : main cable damaged by fishing nets.

From 26 13 00 to 28 18 00 : stoppage due to main engine troubles.

From 29 21 00 to 33 18 00 : stoppage to disembark personnel.

From 34 08 40 to 38 04 20 : stoppage due to main engine troubles.

From 38 06 30 to 42 04 00 : stoppage due to a failure of the PDP 8/I computer of the Satellite Navigation System.

From 42 15 30 to 46 21 30 : end of cruise 2.

The ship berthed at Port Hedland on August 18th, 1972.

Cruise 3

The M/V Lady Christine left Port Hedland on August 21st, 1972 ; the working periods were as follows :

From 50 12 00 to 54 05 30 : stoppage due to main cable problems.

From 54 13 50 to 57 23 00 : stoppage due to main engine troubles.

From 58 06 20 to 60 09 20 : stoppage due to main engine troubles.

From 60 13 00 to 61 16 50 : stoppage due to main engine troubles ; call in Port Hedland.

From 64 23 50 to 71 10 40 : end of cruise 3.

The ship berthed at Broome on September 12th, 1972.

Cruise 4

The ship left Broome on September 14th, 1972 ; the working periods were as follows :

From 75 00 40 to 77 05 00 : stoppage due to gravitymeter failure.

From 80 00 00 to 85 05 00 : end of cruise 4.

The ship berthed at Carnarvon on September 25th, 1972. Cruise 4 ended survey 17.

Note : during the whole of survey 17, channel 1 of the main cable was used in place of the Geotech cable which was completely overhauled.

III.3.11 - Survey 18 (Fig. 21)

It consisted of three cruises covering the whole West Coast of Australia ; its geographical limits were as follows :

	North	South	East	West
Cruise 1	14°30'S	25°30'S	121°00'E	110°30'E
Cruise 2	13°30'S	16°30'S	132°00'E	118°30'E
Cruise 3	17°30'S	35°30'S	108°00'E	115°30'E

The shore station was located first at Onslow (until day 11), then at Darwin (until day 45) and finally at Albany (Fig. 3).

The Geotech cable, back on board, was operational for the whole of survey 18.

Cruise 1

The ship left Carnarvon on September 27th, 1972. The working period was as follows :

From 02 17 50 to 11 06 00 : end of cruise 1 due to unsatisfactory performance of the ship's main engine.

The M/V Lady Christine berthed at Darwin on October 9th, 1972. During this call, important maintenance work was carried out on the main engine of the ship.

Cruise 2

The ship left Darwin on October 13th, 1972 ; the working periods were as follows :

From 21 06 40 to 32 02 15 : stoppage due to a supply boat rendez-vous.

From 34 15 50 to 40 06 00 : stoppage due to main engine troubles.

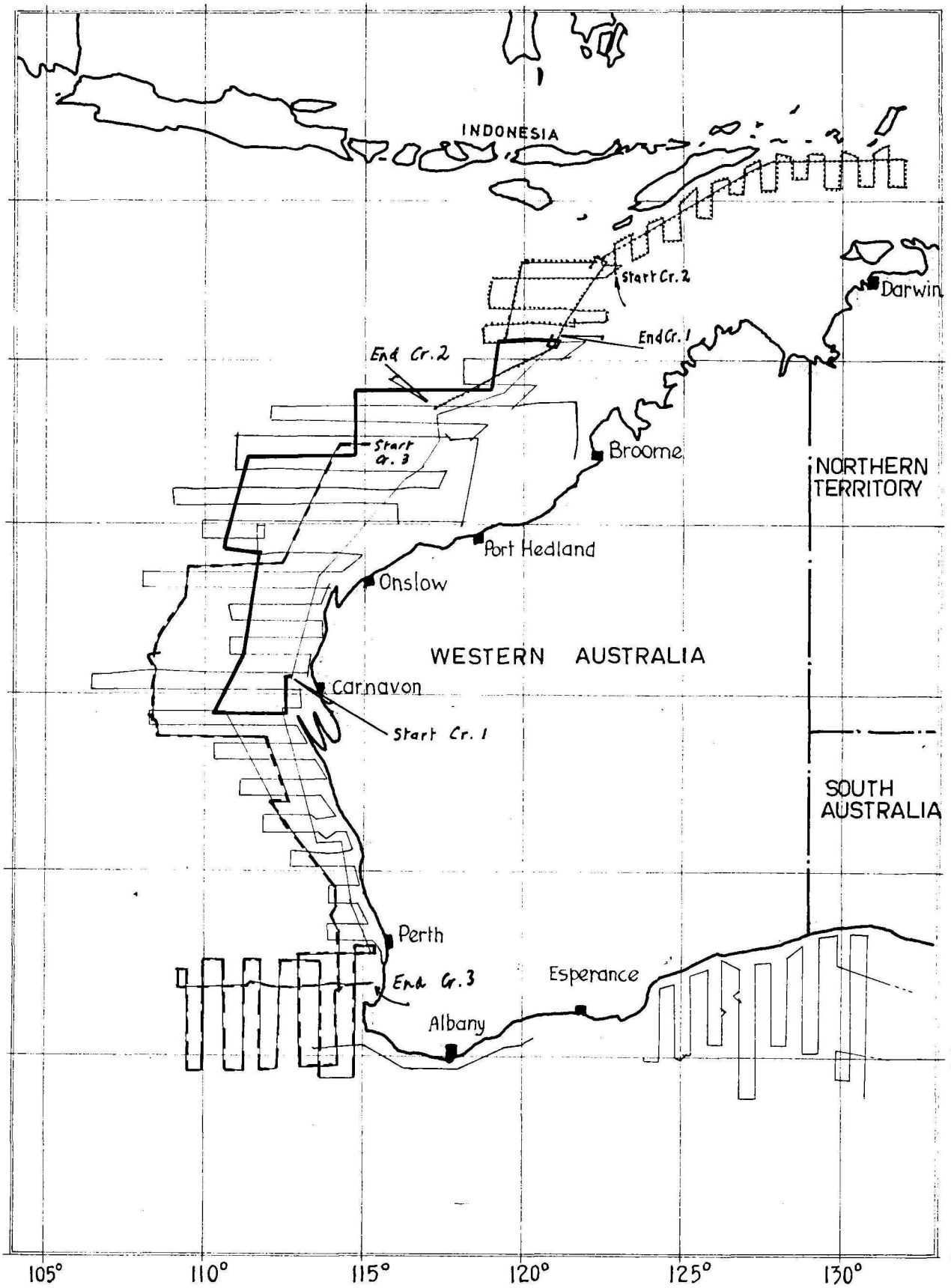
Fig. 21

LOCATION SKETCH for

SOUTH, WEST and NORTH COASTS OF AUSTRALIA

SCALE 1 / 20000000

SURVEY 18



From 40 14 20 to 43 03 30 : stoppage due to a Sparker system breakdown.

From 43 16 20 to 45 20 30 : end of cruise 2.

The ship berthed at Port Hedland on November 11th, 1972.

Cruise 3

The ship left Port Hedland on November 14th, 1972 ; the working periods were as follows :

From 50 19 00 to 53 21 50 : stoppage due to bad weather.

From 56 03 10 to 56 20 40 : stoppage due to a DAS breakdown.

From 57 02 10 to 60 05 30 : stoppage due to bad weather ; short call in Freemantle.

From 62 04 30 to 62 23 20 : stoppage due to bad weather.

From 63 07 40 to 74 10 00 : stoppage due to unsatisfactory operation of the main cable.

From 74 17 00 to 75 17 00 : end of cruise 3.

The ship berthed at Freemantle on December 10th, 1972. Cruise 3 ended survey 18.

III.3.12 - Survey 19

It consisted of one cruise covering the South West Coast of Australia ; its geographical limits were as follows :

North	South	East	West
32° S	38° S	130° E	109° E

The M/V Lady Christine left Freemantle on December 13th, 1972. The working periods were as follows :

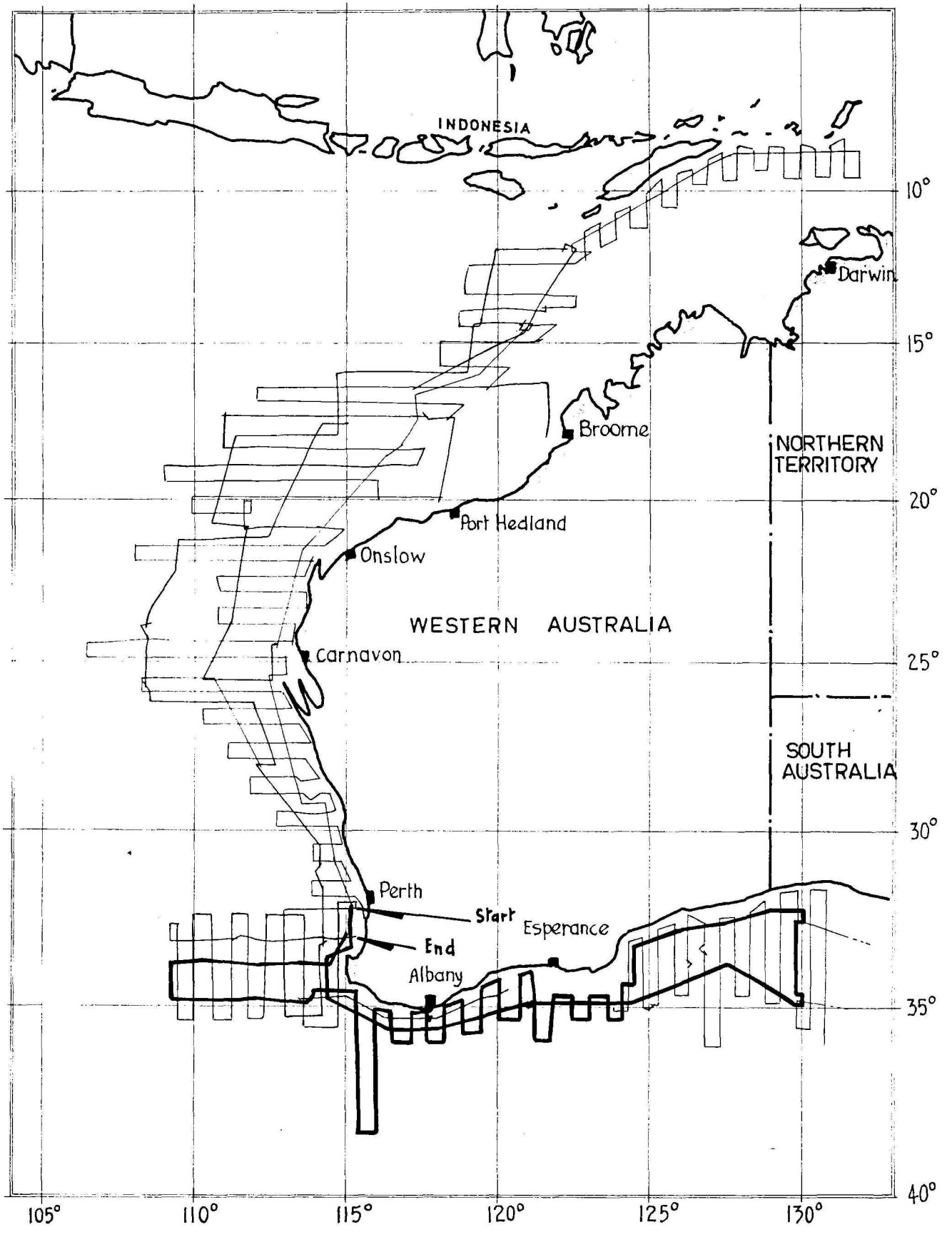
Fig. 22

LOCATION SKETCH for

SOUTH, WEST and NORTH COASTS OF AUSTRALIA

SCALE 1 / 20000000

SURVEY 19



From 02 03 30 to 08 19 00 : short call in Albany to take on additional supplies.

From 11 04 00 to 21 08 30 : stoppage due to bad weather.

From 22 01 50 to 24 17 00 : end of survey 19.

The M/V Lady Christine berthed at Freemantle on January 6th, 1973.

Survey 19 ended the Combined Marine Geophysical survey of the Continental Margins of Australia.

IV - PRODUCTION, STATISTICS

IV.1. - PRODUCTION

Fig. 23 to 36 and enclosure 4 give statistical data for the survey. The meaning of each heading is as follows :

- Working time (WT) : time spent by the ship on data gathering.
- Travelling time (T) : travelling from port to start of a profile and reverse.

  travelling between profiles without collection of data.
- Supply boat (SB) : corresponds to a break in production either for rendez-vous with a supply boat, or for a short call in a Port to collect supplies if no supply boat is available.
- Bad weather (BW) : break in production due to bad weather.
- Major breakdown (MB) : break in production due to breakdown or failure of a major piece of geophysical equipment (or of the ship itself).
- Port (P) : time spent in a port at the end of a cruise (the call of cruise n is the time spent in harbour between cruises n and n + 1).
- Mileage (M) : mileage surveyed (in nautical miles).
- Speed : ratio $\frac{M}{WT}$ given in knots.
- Total time at sea (TTS) : is the sum WT + T + SB + BW + MB.
- Total time (TT) : is the sum TTS + P.
- Figures 23 to 33 and 36 give this information for each cruise, and the breakdown of the figures in percentages for the whole survey. In order to remain consistent, the data of the test cruises are not included in the total statistics.

PRODUCTION STATISTICS SURVEY 5

Cruise	Total time TT	Port P	Total time at sea TTS	Working time WT	Major breakdown MB	Bad weather BW	Supply boat SB	Travelling T
1	424.20	156.15	268.05	263.25	0	0	0	04.40
2	456.00	80.00	376.00	364.50	07.10	0	0	04.00
3	505.40	114.25	391.15	387.15	0	0	0	04.00
4	546.00	212.40	333.20	290.00	39.20	0	0	04.00
5	444.00	102.00	342.00	338.00	0	0	0	04.00
TOTAL	2376.00	665.20	1710.40	1643.30	46.30	0	0	20.40
MONTHS	3.3	0.924	2.376	2.283	0.064	0	0	0.029
REDUCED TO 1 MONTH	1	0.280	0.720	0.692	0.019	0	0	0.009
DAY / MONTH	30	8.4	21.6	20.76	0.570	0	0	0.27
TTS = 100%	-	-	100	96.11	2.64	0	0	1.25
TT=100%	100	280	72 TTS + PORT = TT	69.2	1.9	0	0	0.9

Fig.23

PRODUCTION STATISTICS SURVEY 10

Cruise	Total time TT	Port P	Total time at sea TTS	Working time WT	Major breakdown MB	Bad weather BW	Supply boat SB	Travelling T
1	324.40	72.00	252.40	188.46	10.00	0	0	53.54
TOTAL	324.40	72.00	252.40	188.46	10.00	0	0	53.54
MONTHS	0.451	0.1	0.351	0.262	0.014	0	0	0.075
REDUCED TO 1 MONTH	1	0.222	0.778	0.581	0.031	0	0	0.166
DAY / MONTH	30	6.66	23.34	17.43	0.93	0	0	4.98
TTS = 100%	-	-	100	74.7	4.0	0	0	21.3
TT=100%	100	22.2	77.8 TTS + PORT = TT	16.6	3.1	0	0	16.6

Fig.24

PRODUCTION STATISTICS SURVEY 11

Cruise	Total time TT	Port P	Total time at sea TTS	Working time WT	Major breakdown MB	Bad weather BW	Supply boat SB	Travelling T
1	394.00	55.00	339.00	210.00	0	84.00	11.00	34.00
2	529.00	75.00	454.00	138.20	0	252.20	19.00	45.20
TOTAL	923.00	130.00	793.00	348.20	0	335.20	30.00	79.20
MONTHS	1.282	0.181	1.101	0.484	0	0.466	0.042	0.11
REDUCED TO 1 MONTH	1.0	0.141	0.859	0.377	0	0.363	0.033	0.086
DAY / MONTH	30	4.23	25.77	11.31	0	10.89	0.99	2.58
TTS = 100%	-	-	100	44	0	42	4	10
TT=100%	100	14.1	85.9 TTS + PORT = TT	37.7	0	36.3	3.3	8.6

Fig.25

PRODUCTION STATISTICS SURVEY 12

Cruise	Total time TT	Port P	Total time at sea TTS	Working time WT	Major breakdown MB	Bad weather BW	Supply boat SB	Travelling T
1	455.00	70.00	385.00	333.20	14.00	0	11.00	26.40
2	611.00	87.30	523.30	333.35	69.10	45.05	0	75.40
3	494.00	74.00	420.00	330.00	0	15.40	0	74.20
4	528.00	73.00	455.00	418.30	0	0	0	36.30
TOTAL	2 088.00	304.30	1 783.30	1 415.25	83.10	60.45	11.00	213.10
MONTHS	2.9	0.423	2.477	1.966	0.115	0.084	0.016	0.296
REDUCED TO 1 MONTH	1	0.146	0.854	0.677	0.040	0.029	0.005	0.103
DAY / MONTH	30	4.38	25.62	20.31	1.2	0.87	0.15	3.09
TTS = 100%	-	-	100	79.2	4.7	3.4	0.6	12.1
TT=100%	100	14.6	85.4 TTS + PORT = TT	67.7	4.0	2.9	0.5	10.3

Fig. 26

PRODUCTION STATISTICS SURVEY 13

Cruise	Total time TT	Port P	Total time at sea TTS	Working time WT	Major breakdown MB	Bad weather BW	Supply boat SB	Travelling T
1	450.10	67.00	383.10	311.30	10.50	0	03.40	57.10
2	439.40	118.00	321.40	215.50	03.50	26.10	0	75.50
3	546.00	72.00	474.00	282.30	92.30	0	42.20	56.40
4	521.20	65.00	456.20	270.50	29.10	110.00	07.20	39.00
5	418.50	26.00	392.50	314.00	54.10	0	0	24.40
TOTAL	2 376.00	348.00	2 028.00	1 394.40	190.30	136.10	53.20	253.20
MONTHS	3.30	0.483	2.817	1.937	0.265	0.189	0.074	0.352
REDUCED TO 1 MONTH	1	0.146	0.854	0.587	0.080	0.057	0.022	0.107
DAY / MONTH	30	4.40	25.60	17.60	2.41	1.72	0.67	3.20
TTS = 100%	-	-	100	68.77	9.39	6.71	2.63	12.49
TT=100%	100	14.65	85.35 TTS + PORT = TT	58.70	8.02	5.73	2.24	10.66

Fig. 27

PRODUCTION STATISTICS SURVEY 14

Cruise	Total time TT	Port P	Total time at sea TTS	Working time WT	Major breakdown MB	Bad weather BW	Supply boat SB	Travelling T
1	646.50	190.30	456.20	321.40	102.55	0	14.30	17.15
2	600.10	68.00	532.10	444.30	66.10	0	0	21.30
3	686.25	150.10	536.15	361.40	40.00	04.10	43.40	86.45
TOTAL	1 933.25	408.40	1 524.45	1 127.50	209.05	04.10	58.10	125.30
MONTHS	2.685	0.567	2.118	1.566	0.290	0.006	0.082	0.174
REDUCED TO 1 MONTH		0.211	0.789	0.583	0.108	0.002	0.031	0.065
DAY / MONTH	30	6.3	23.7	17.5	3.2	0.0	1.0	2.0
TTS = 100%			100	73.8	13.6	0	4.2	8.4
TT=100%	100	21.1	78.9 TTS + PORT = TT	58.3	10.8	0.2	3.1	6.5

Fig. 28

PRODUCTION STATISTICS SURVEY 15

Cruise	Total time TT	Port P	Total time at sea TTS	Working time WT	Major breakdown MB	Bad weather BW	Supply boat SB	Travelling T
1	551.30	182.10	369.20	202.05	108.25	14.40	05.50	38.20
2	598.20	192.0	406.20	165.00	20.00	168.40	15.50	36.50
3	654.30	122.00	532.30	350.10	157.50	11.30	0	13.00
4	400.00	69.30	330.30	219.10	30.50	74.30	0	06.00
TOTAL	2 204.20	565.40	1 638.40	936.25	317.05	269.20	21.40	94.10
MONTHS	3.062	0.786	2.276	1.301	0.440	0.374	0.030	0.131
REDUCED TO 1 MONTH	1	0.257	0.743	0.425	0.144	0.122	0.009	0.043
DAY / MONTH	30	7.7	22.3	12.8	4.3	3.7	0.3	1.2
TTS = 100%	-	-	100	57.4	19.3	16.6	1.3	5.4
TT=100%	100	25.7	74.3 TTS + PORT = TT	42.5	14.4	12.2	0.9	4.3

Fig.29

PRODUCTION STATISTICS SURVEY 16

Cruise	Total time TT	Port P	Total time at sea TTS	Working time WT	Major breakdown MB	Bad weather BW	Supply boat SB	Travelling T
1	512.30	85.00	427.30	341.20	05.20	35.20	0	45.30
2	719.30	80.00	639.30	439.10	108.50	45.30	04.40	44.20
3	510.00	78.00	432.00	343.10	18.25	0	41.45	28.40
4	562.00	46.45	515.00	279.10	25.05	194.30	0	16.30
TOTAL	2 304.00	289.45	2 014.15	1 402.50	154.40	275.20	46.25	135.00
MONTHS	3.2	0.40	2.8	1.95	0.21	0.38	0.07	0.19
REDUCED TO 1 MONTH	1	0.13	0.87	0.61	0.06	0.12	0.02	0.06
DAY / MONTH	30	3.75	26.25	18.28	1.97	3.56	0.66	1.78
TTS = 100%	-	-	100	69.64	7.50	13.56	2.52	6.78
TT=100%	100	12.6	87.4 TTS + PORT = TT	60.9	6.7	11.9	2.0	5.9

Fig. 30

PRODUCTION STATISTICS SURVEY 17

Cruise	Total time TT	Port P	Total time at sea TTS	Working time WT	Major breakdown MB	Bad weather BW	Supply boat SB	Travelling T
1	586.20	88.50	497.30	326.10	04.00	125.00	0	42.15
2	584.00	68.20	515.40	444.50	46.40	0	0	24.10
3	583.40	103.25	480.15	404.20	13.20	0	06.00	56.35
4	286.00	12.30	273.30	177.20	58.15	0	0	37.55
TOTAL	2 040.00	273.05	1 766.55	1 352.40	122.15	125.00	06.00	160.55
MONTHS	2.833	0.379	2.454	1.879	0.170	0.174	0.008	0.223
REDUCED TO 1 MONTH	1	0.134	0.866	0.663	0.060	0.061	0.003	0.079
DAY / MONTH	30	4.02	25.98	19.89	1.80	1.83	0.09	2.37
TTS = 100%	-	-	100	76.56	6.93	7.04	0.35	9.12
TT=100%	100	13.4	86.6 TTS + PORT = TT	66.3	6.0	6.1	0.3	7.9

Fig. 31

PRODUCTION STATISTICS SURVEY 18

Cruise	Total time TT	Port P	Total time at sea TTS	Working time WT	Major breakdown MB	Bad weather BW	Supply boat SB	Travelling T
1	432.00	146.00	286.00	204.10	0	0	0	81.50
2	736.00	88.00	648.00	507.05	31.30	0	61.35	47.50
3	704.00	69.00	635.00	476.45	24.00	68.45	28.30	37.00
TOTAL	1 872.00	303.00	1 569.00	1 188.00	55.30	68.45	90.05	166.40
MONTHS	2.6	0.421	2.179	1.650	0.078	0.095	0.125	0.231
REDUCED TO 1 MONTH	1.0	0.162	0.838	0.634	0.030	0.036	0.049	0.089
DAY / MONTH	30	4.86	25.14	19.02	0.9	1.08	1.47	2.67
TTS = 100%	-	3.57	100	75.66	4.30	5.85	5.82	10.62
TT=100%	100	16.2	83.8 TTS + PORT = TT	63.4	3.0	3.6	4.9	8.9

Fig. 32

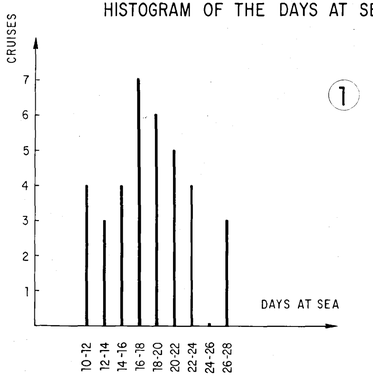
PRODUCTION STATISTICS SURVEY 19

Cruise	Total time TT	Port P	Total time at sea TTS	Working time WT	Major breakdown MB	Bad weather BW	Supply boat SB	Travelling T
1	648.00	87.00	561.00	467.15	26.30	35.15	04.30	27.30
TOTAL	648.00	87.00	561.00	467.15	26.30	35.15	04.30	27.30
MONTHS	0.900	0.121	0.779	0.649	0.037	0.049	0.006	0.038
REDUCED TO 1 MONTH	1.0	0.134	0.866	0.721	0.042	0.054	0.007	0.042
DAY / MONTH	30	4.02	25.98	21.63	1.26	1.62	0.21	1.26
TTS = 100%	-	-	100	83.3	4.7	6.3	0.8	4.9
TT=100%	100	13.4	86.6 TTS + PORT = TT	72.1	4.2	5.4	0.7	4.2

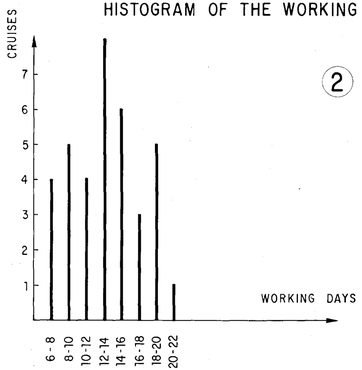
Fig.33

STATISTICS - HISTOGRAMS

HISTOGRAM OF THE DAYS AT SEA BY CRUISES

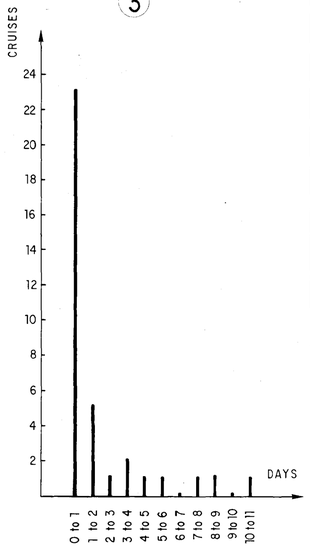


HISTOGRAM OF THE WORKING DAYS BY CRUISES



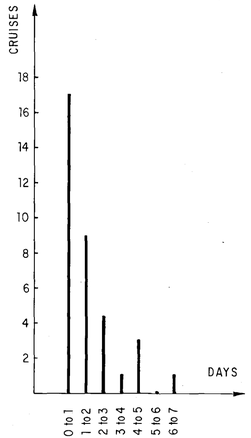
IMMOBILISATIONS BAD WEATHER

HISTOGRAM BY CRUISES



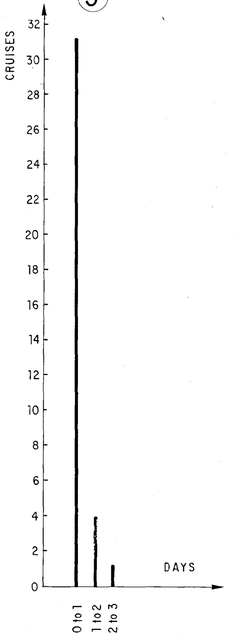
IMMOBILISATIONS DUE TO MAJOR BREAKDOWNS

HISTOGRAM BY CRUISE



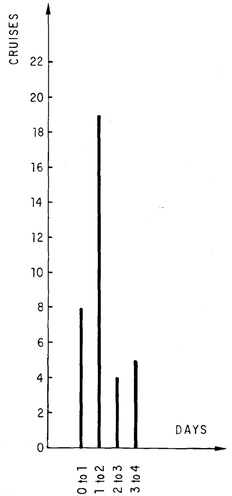
IMMOBILISATIONS DUE TO RENDEZVOUS WITH SUPPLY BOAT

HISTOGRAM BY CRUISES



IMMOBILISATIONS DUE TO TRAVELLING PERIODS

HISTOGRAM BY CRUISES



PORT OF CALL DURATION

HISTOGRAM

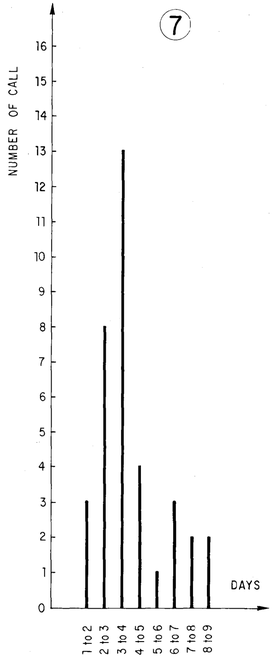
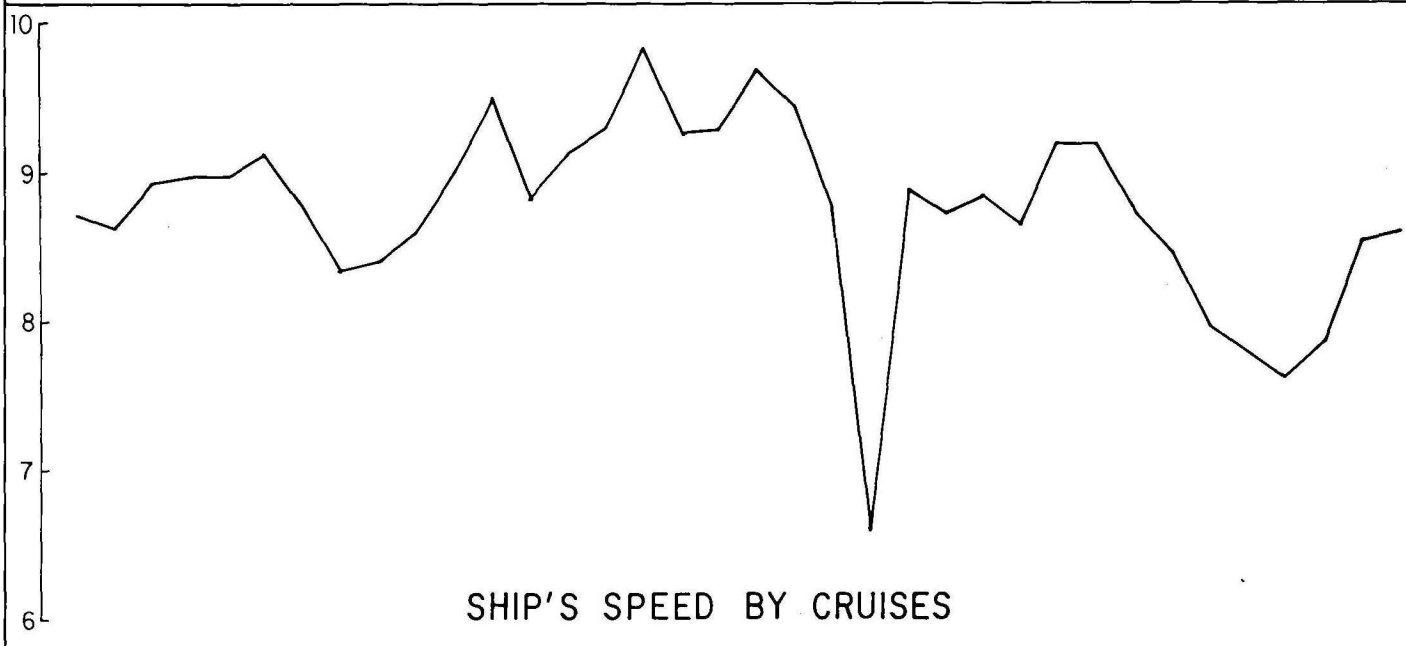
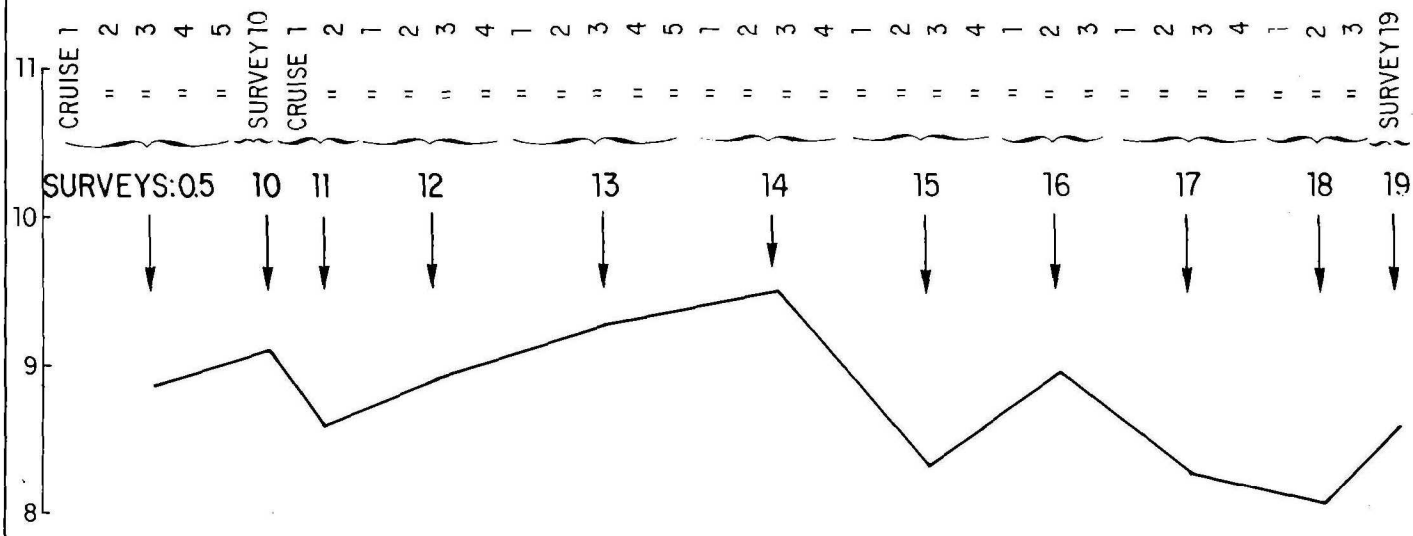


Fig. 35

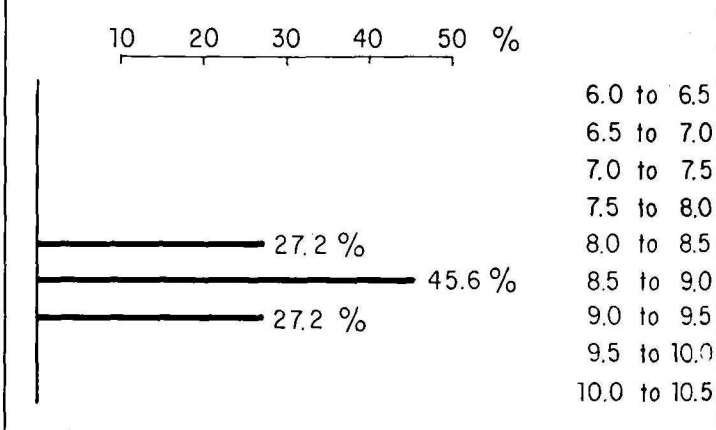
BMR SURVEY : SHIP'S SPEED



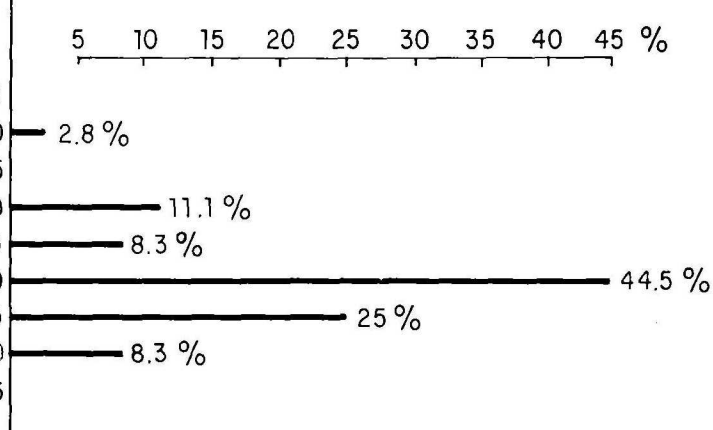
SHIP'S SPEED BY CRUISES



SHIP'S SPEED BY SURVEYS



HISTOGRAM OF THE SPEED BY CRUISES



HISTOGRAM OF THE SPEED BY SURVEYS

GENERAL STATISTICS

Survey	Total time TT	Port P	Total time at sea TTS	Working time WT	Major breakdown MB	Bad weather BW	Supply boat SB	Travelling T	Mileage NAUTICAL MILES	Speed KNOTS
5	2 376 00	665 20	1710 40	1643 30	46 30	00 00	00 00	20 40	14 566 0	8.86
10	324 40	72 00	252 40	188 46	10 00	00 00	00 00	53 54	1 719	9.11
11	923 00	130 00	793 00	348 20	0	335 20	30 00	79 20	2 996	8.60
12	2 088 00	304 30	1783 30	1415 25	83 10	60 45	11 00	213 10	12 614	8.91
13	2 376 00	348 00	2028 00	1394 42	190 28	136 10	53 20	253 20	12 918	9.26
14	1 933 25	408 40	1524 45	1127 50	209 05	04 10	58 10	125 30	10 714	9.50
15	2 204 20	565 40	1638 40	936 25	317 05	269 20	21 40	94 10	7 795	8.32
16	2 304 00	289 45	2014 15	1402 50	154 40	275 20	46 25	135 00	12 575	8.96
17	2 040 00	273 05	1766 55	1352 40	122 15	125 05	06 00	160 55	11 192	8.27
18	1 872 00	303 00	1569 00	1188 00	55 30	68 45	90 05	166 40	9 622	8.09
19	648 00	87 00	561 00	467 15	26 30	35 15	04 30	27 30	4 017	8.60
TOTAL	19 089 25	3447 00	15 642 25	11465 43	1215 13	1310 10	321 10	1330 09	100 728 MILES 186 548 KM	8.78
MONTHS	26.51	4.79	21·72	15.92	1.69	1.82	0.45	1.84	–	–
REDUCED TO 1 MONTH	1	0.181	0.819	0.601	0.064	0.068	0.017	0.069	–	–
DAYS / MONTH	30	5 43	24.57	18.03	1.92	2.04	0.510	2.07	–	–
TTS = 100 %	–	–	100	73.38	7.82	8.31	2.07	8.42	–	–
TT=100 %	100	18.1	81.9	60.1	6.4	6.8	1.7	6.9	–	–

Fig. 36

- Enclosure 4 shows these results in the form of a graph.
- Figure 35 provides statistical data of the cruise speed throughout the survey.

IV.2. - SONOBUOYS

The results of the refraction probes are as follows :

S O N O B U O Y S			
Survey	Good	Bad	TOTAL
5	38	30	68
10	4	0	4
11	4	1	5
12	18	15	33
13	28	16	44
14	35	18	53
15	19	6	25
16	26	11	37
17	16	8	24
18	19	4	23
19	8	2	10
All Surveys	215	111	326

The geographical location of each location probe is given on the location maps of enclosures 5 to 12.

APPENDIX

APPENDIX N° 1

CORRESPONDENCE CALENDAR DAYS - SURVEY DAYS

Survey	Cruise	Survey Days From	Survey Days To	Calendar Days From	Calendar Days To
05	1	01	12	September 04th, 1970	September 15th, 1970
05	2	18	34	September 21st, 1970	October 07th, 1970
05	3	37	53	October 10th, 1970	October 26th, 1970
05	4	58	72	October 31st, 1970	November 14th, 1970
05	5	81	95	November 23rd, 1970	December 07th, 1970
10	1	01	09	December 13th, 1970	December 21st, 1970
11	1	01	14	February 16th, 1971	March 01st, 1971
11	2	18	35	March 05th, 1971	March 22nd, 1971
12	1	01	16	April 07th, 1971	April 22nd, 1971
12	2	20	38	April 25th, 1971	May 13th, 1971
12	3	45	60	May 20th, 1971	June 04th, 1971
12	4	66	84	June 10th, 1971	June 28th, 1971
13	1	01	15	July 02nd, 1971	July 16th, 1971
13	2	19	29	July 20th, 1971	July 30th, 1971
13	3	38	55	August 08th, 1971	August 25th, 1971
13	4	60	73	August 30th, 1971	September 12th, 1971
13	5	82	97	September 21st, 1971	October 06th, 1971
14	1	06	21	October 14th, 1971	October 29th, 1971
14	2	28	48	November 5th, 1971	November 25th, 1971
14	3	53	76	November 30th, 1971	December 23rd, 1971
15	1	02	15	December 29th, 1971	January 11th, 1972
15	2	24	40	January 20th, 1972	February 05th, 1972
15	3	50	69	February 15th, 1972	March 03rd, 1972
15	4	77	86	March 13th, 1972	March 22nd, 1972
16	1	02	19	March 30th, 1972	April 16th, 1972
16	2	22	48	April 19th, 1972	May 15th, 1972

Survey	Cruise	Survey Days From	Survey Days To	Calendar Days From	Calendar Days To
16	3	52	69	May 19th, 1972	June 06th, 1972
16	4	74	93	June 10th, 1972	June 29th, 1972
17	1	02	20	July 04th, 1972	July 22nd, 1972
17	2	25	46	July 27th, 1972	August 17th, 1972
17	3	50	71	August 21th, 1972	September 11th, 1972
17	4	75	85	September 15th, 1972	September 25th, 1972
18	1	02	11	September 27th, 1972	October 06th, 1972
18	2	21	45	October 16th, 1972	November 09th, 1972
18	3	50	15	November 11th, 1972	December 09th, 1972
19	1	02	24	December 14th, 1972	January 05th, 1973

1975/15/

BUREAU OF MINERAL RESOURCES

ENCL. N° 1

M/V LADY CHRISTINE

DATA ACQUISITION SYSTEM

COMPAGNIE GENERALE DE GEOPHYSIQUE

HIGH SPEED PUNCHED TAPE READER
2748 A H. P.

MAGNETIC TAPE RECORDER
7970 A H. P.

TELETYPE ASR 35
(supply 110 v. 60Hz.)
2754 B H. P.

MAGNETIC TAPE RECORDER
(supply 110 v. 60Hz.)
2020 B H. P.

4 D. to A. CONVERTERS
SERCEL

SEQUENTIAL PAPER RECORDER
601 W + W Electronics

A. to D. MULTIVERTER
14 BITS
Up to 32 channels
2310 B H. P.

COMPUTER
16k MEMORIES
(supply 220 v. 60Hz.)
2116 B H.P.
Auxiliary Power Supply
H. P.

G. M. T. Time
Sparker shot inst.
NAVIGATION ROOM CLOCK
B. M. R.

INTERFACES
MAIN SYSTEM
(supply 220 v. 60Hz.)
SERCEL

Electronic Counter
Electronic Counter
Buffers

Rubidium Frequency Standard
(5 MC) 1 MC 100 kC
V. L. F.
TRACOR

10 mm marks to all recorders

Start EDO Count
Sparker Shot Inst. to Seismic Container
Comparison Pulse from Seismic Container
One Streamer Trace
First echo = bottom
Stop EDO Count

INTERFACE PART "A"
SERCEL

DATA COUPLER
DIGI-DATA

MAGNETIC TAPE RECORDER
GRAVIMETER
LACOSTE
MAGNETOMETER
VARIAN

GRAVITY PAPER RECORDER
T. I.
ACCELEROMETERS PAPER RECORDERS
E. A.
MAGNETOMETER PAPER RECORDER
VARIAN

CROSS - COUPLING COMPONENTS PAPER RECORDER RIKADENKI

INTERFACE PART "B"
CHOICE
SERCEL

Time Interval Counter depth digitizer
DIGITRACK EDO

FATHOMETER 4000m.
E L A C

STRIP CHART DISPLAY

Time Interval Counter depth digitizer for ATLAS
"EDIG" ATLAS

DESO FATHOMETER 1000
ATLAS

STRIP CHART DISPLAY

D. to A. CONVERTER
580 A H.P.

SEQUENTIAL PAPER RECORDER
WESTRONICS

ELECTRONIC LOG SYSTEM
CHERNIKEEFF

PRESSURE LOG SYSTEM
HARTMANN and BRAUN

4D. to A. CONVERTERS
SERCEL

FILTER

DOPPLER SONAR SYSTEM
MARQUARDT

SINE - COSINE POTENTIOMETER C.G.G.

FILTER

COMPASS
ANSCHÜTZ

DISPLAY
ANSCHÜTZ

HEADING ENCODER
SAGEM

PAPER RECORDER (Analog)
LINAX

ANEMOMETER
ALCYON

PHASES RECORDER
WESTRONICS

AMPLITUDES RECORDER
WESTRONICS

FILTER

Crystal Frequency Standard
5 MC (1 MC 100 kC)
NAVSHIPS

SATELLITE DOPPLER RECEIVER
I. T. T.

POWER SUPPLY
From 220 v 50 Hz
to 110 v 60 Hz
A. T. E. I.

COMPUTER
8K MEMORIES
plus High Speed Punched Tape Reader and I.T.T.'s Interface to Receiver
PDP 8/I DIGITAL

TELETYPE
ASR 33

CORRELATION ECHO - SOUNDER PROCESSOR
CESP 1 Raytheon

PRECISION DEPTH DIGITIZER
PDD 200A Raytheon

TRANSDUCER

POWER TRANSMITTER RECEIVER
PTR 101A Raytheon

GRAPHIC RECORDER
4100 EPC

Key

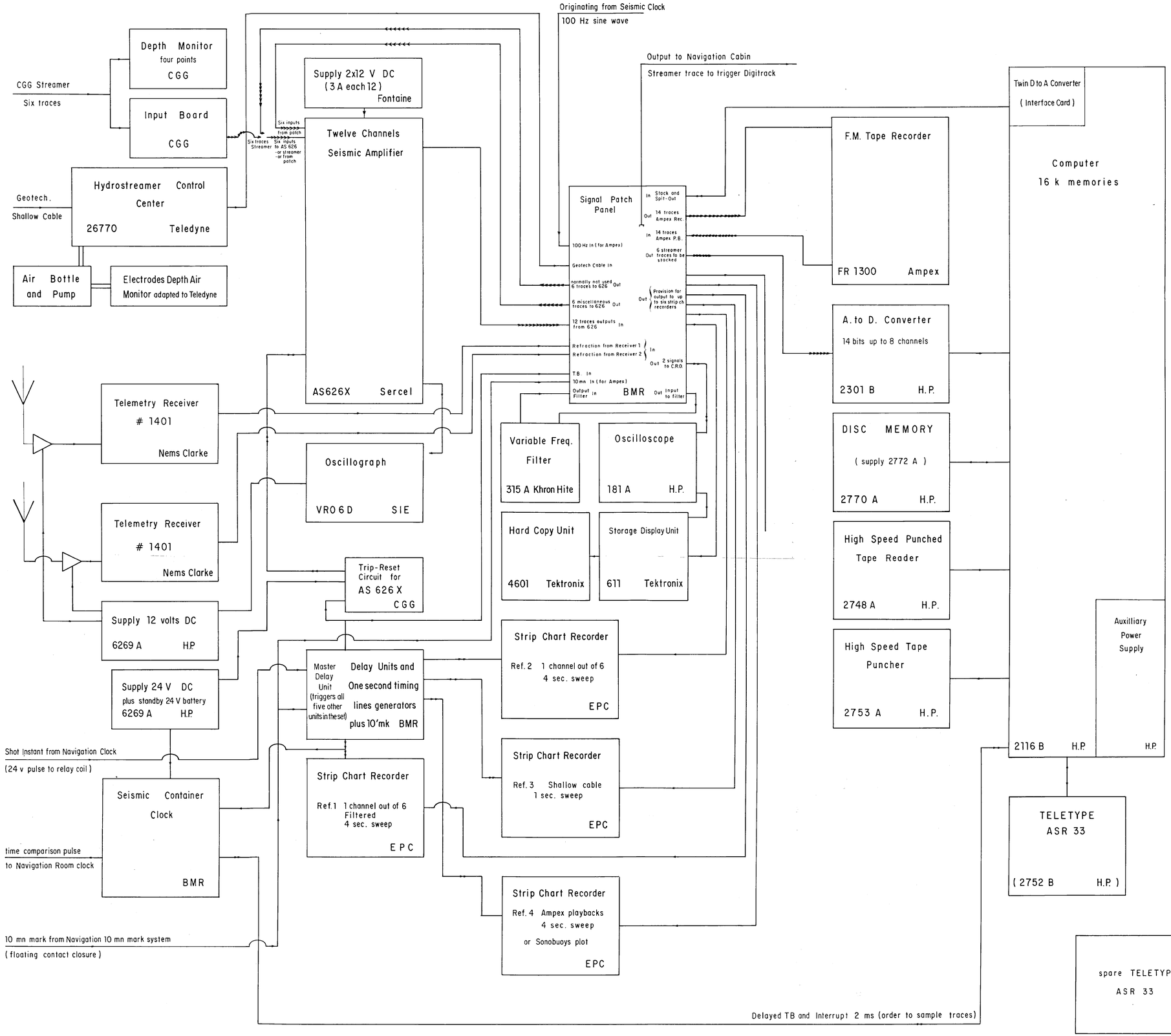
BUREAU OF MINERAL RESOURCES

ENCL.N°2

M/V LADY CHRISTINE

SEISMIC SYSTEM

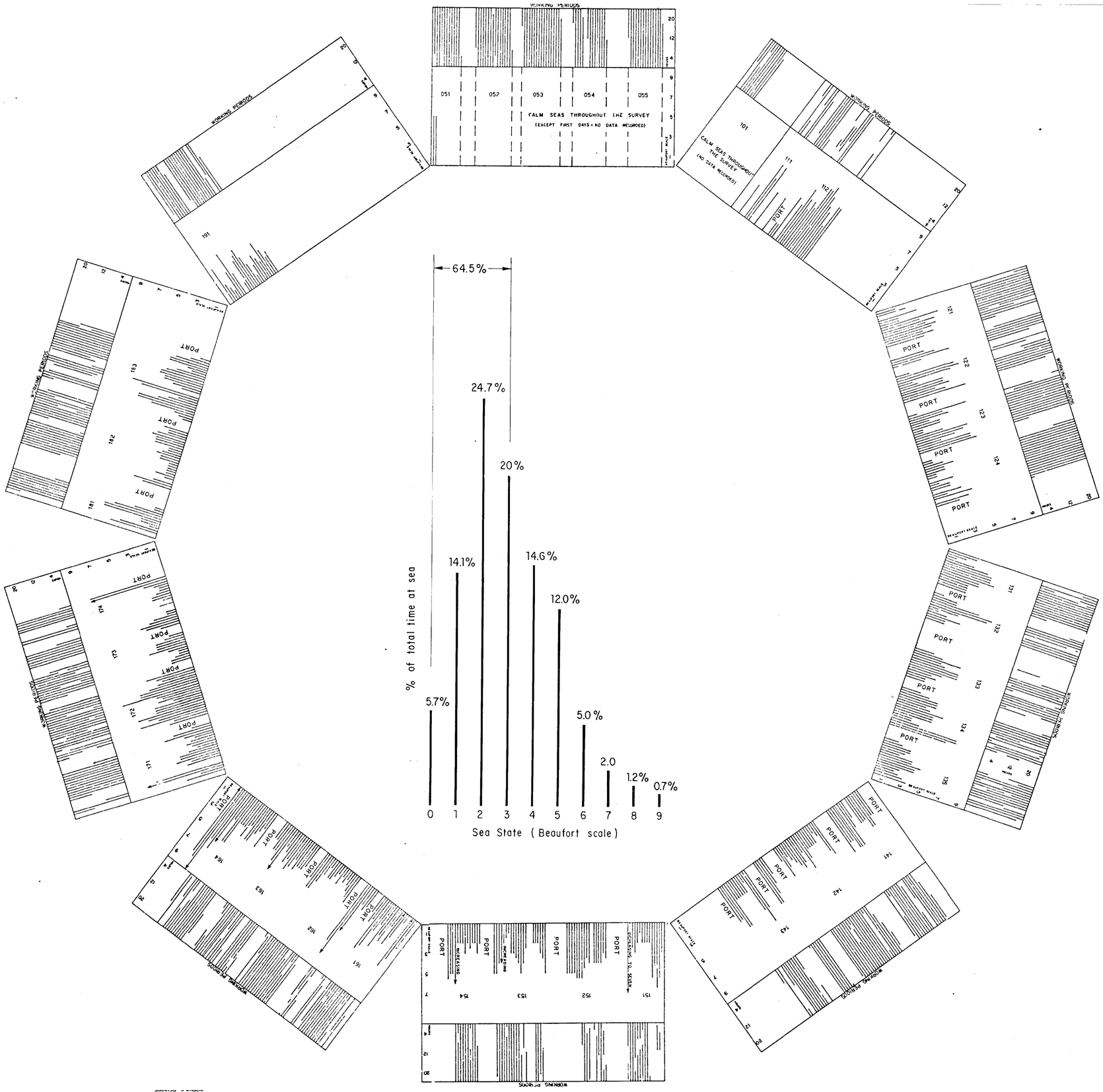
COMPAGNIE GENERALE DE GEOPHYSIQUE
6, Rue Galvani - 91301 - MASSY - FRANCE



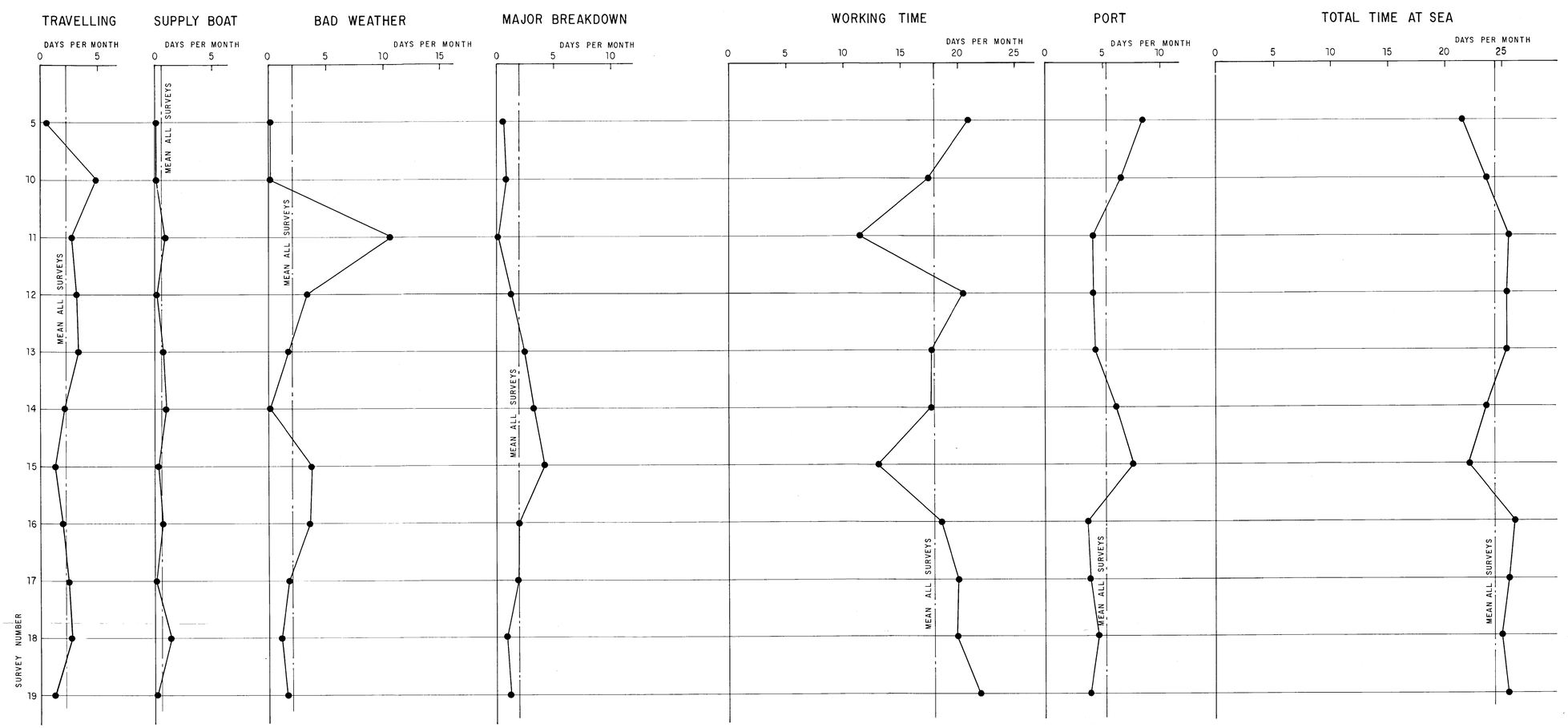
BUREAU OF MINERAL RESOURCES ENCL.3

GEOPHYSICAL SURVEYS OF THE CONTINENTAL MARGINS OF AUSTRALIA, GULF OF PAPUA AND THE BISMARCK SEA

WEATHER



COMPAGNIE GENERALE DE GEOPHYSIQUE



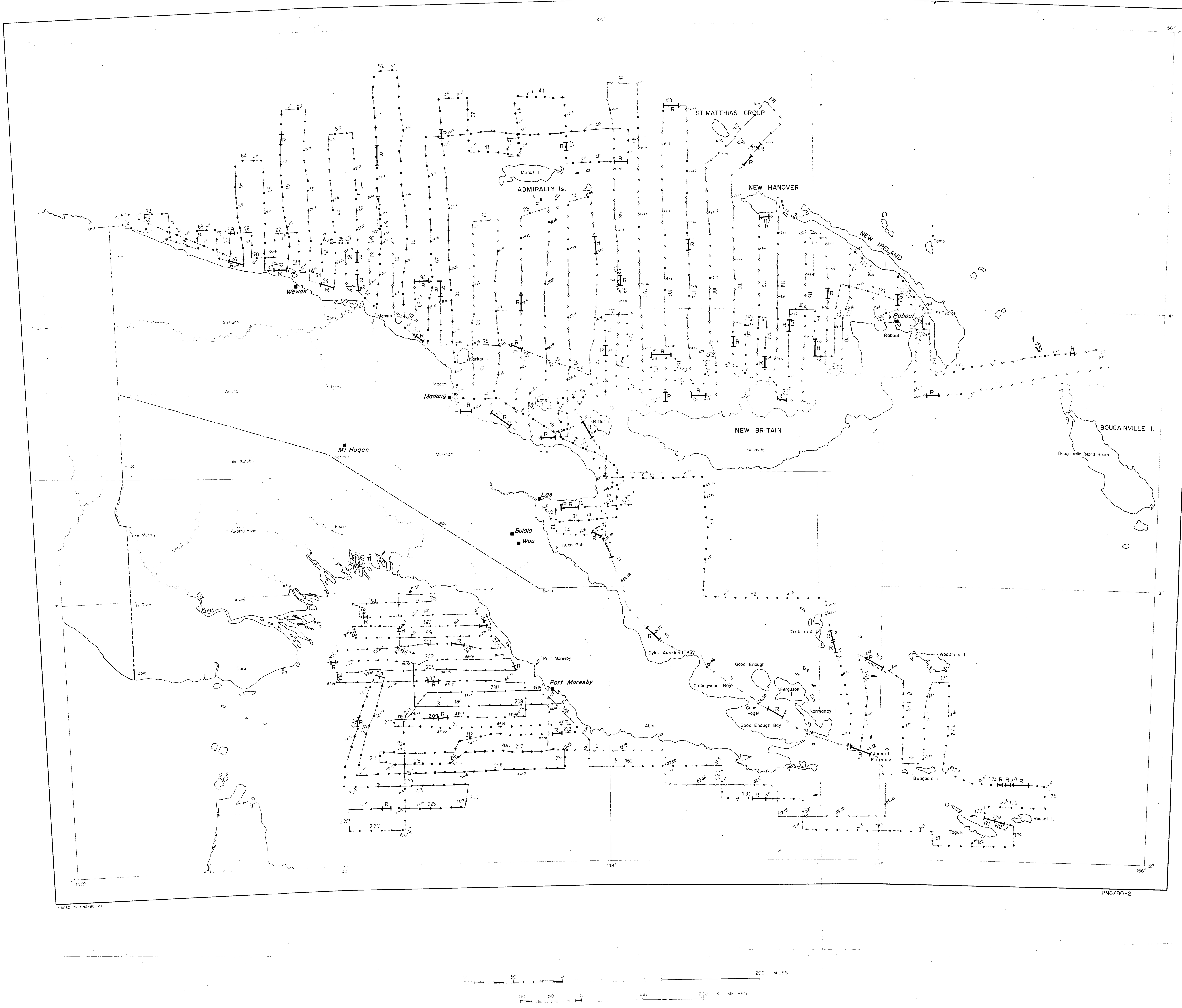
BUREAU OF MINERAL RESOURCES

ENCL.4

GEOPHYSICAL SURVEYS OF THE CONTINENTAL MARGINS OF AUSTRALIA, GULF OF PAPUA AND THE BISMARCK SEA

PRODUCTION STATISTICS

COMPAGNIE GENERALE DE GEOPHYSIQUE



BASED ON PNG/BO-2

PNG/BO-2

BUREAU OF MINERAL RESOURCES — ENCL. 5

GEOPHYSICAL SURVEYS OF THE CONTINENTAL MARGINS OF AUSTRALIA, GULF OF PAPUA AND THE BISMARCK SEA

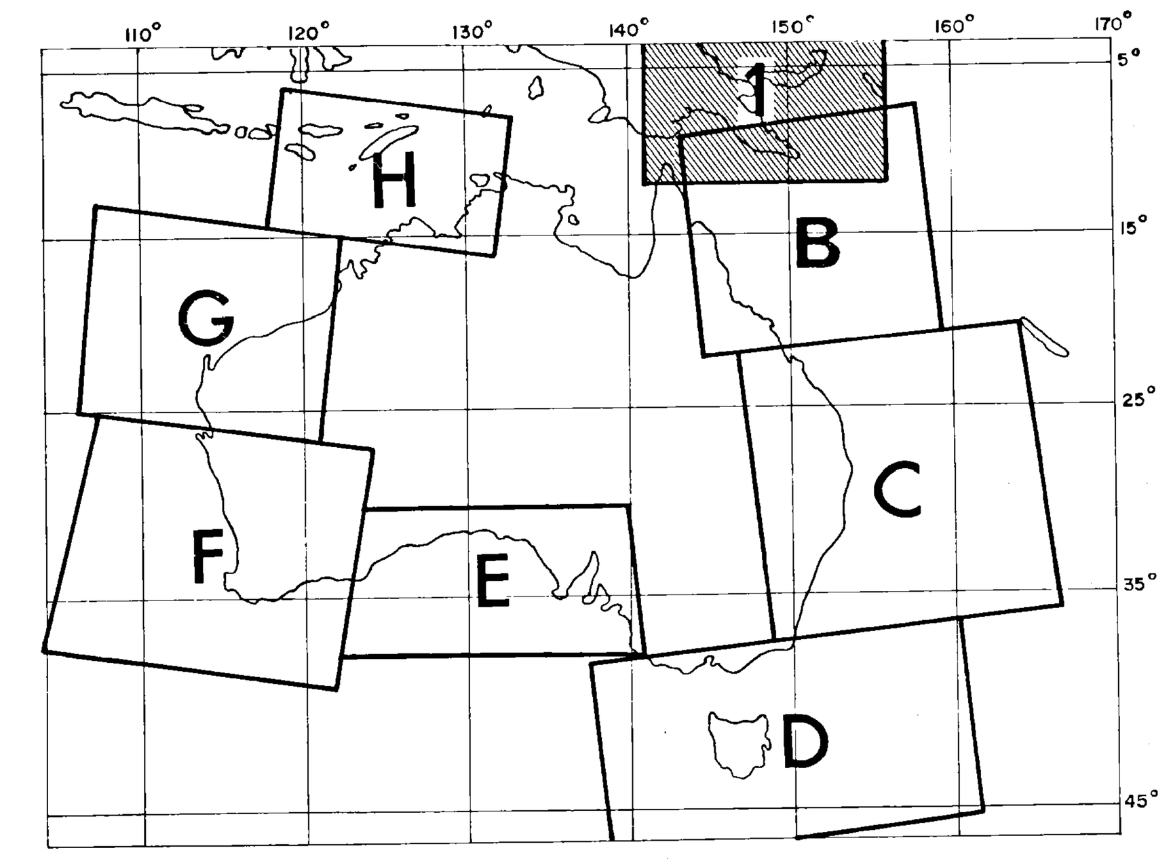
LOCATION MAP

SONOBUOYS

LEGEND

HOURLY POSITION

2R — REFRACTION PROBE AND NUMBER OF SONOBUOYS USED



COMPAGNIE GENERALE DE GEOPHYSIQUE

BUREAU OF MINERAL RESOURCES

ENCL. 6

GEOPHYSICAL SURVEYS OF THE CONTINENTAL MARGINS OF AUSTRALIA, GULF OF PAPUA AND THE BISMARCK SEA

LOCATION MAP

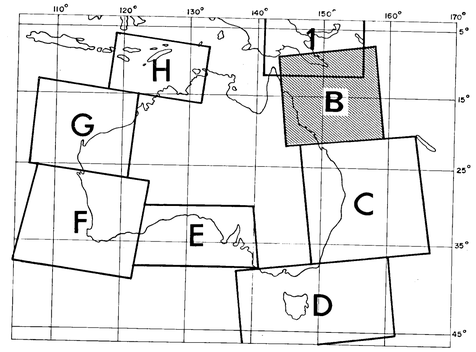
SONOBUOYS

LEGEND

HOURLY POSITION

2R REFRACTION PROBE AND NUMBER OF SONOBUOYS USED

FOR SURVEY 5 REFRACTION PROBES, SEE AREA Nº 1



COMPAGNIE GENERALE DE GEOPHYSIQUE

144°
147°
150°
153°
156°
12°
16°
20°
PAPUA
CORAL SEA
D'ENTRECASTEAUX ISLANDS
SUDEST I.
ROSSEL
Cape Melville
Cooktown
Mossman
Cairns
Wrotham Park
Atherton
Innisfail
Einasleigh
Georgetown
Ingham
HINCHINBROOK ISLAND
Clarke River
Townsville
MAGNETIC I.
Ayr
Hughenden
Charters Towers
Bowen
Broserpine
Tangorin
Buchanan
Mt Coolon
Mackay
Percy Isles
Mutteburra
Galilee
Clermont
St Lawrence
Port Clinton

BUREAU OF MINERAL RESOURCES ENCL.7

GEOPHYSICAL SURVEYS OF THE CONTINENTAL MARGINS OF AUSTRALIA, GULF OF PAPUA AND THE BISMARCK SEA

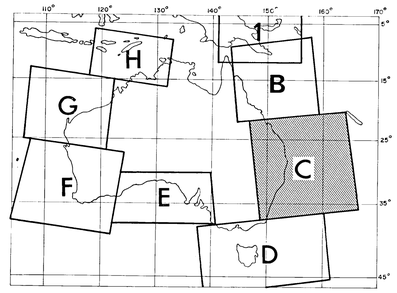
LOCATION MAP

SONOBUOYS

LEGEND

HOURLY POSITION

2R REFRACTION PROBE AND NUMBER OF SONOBUOYS USED



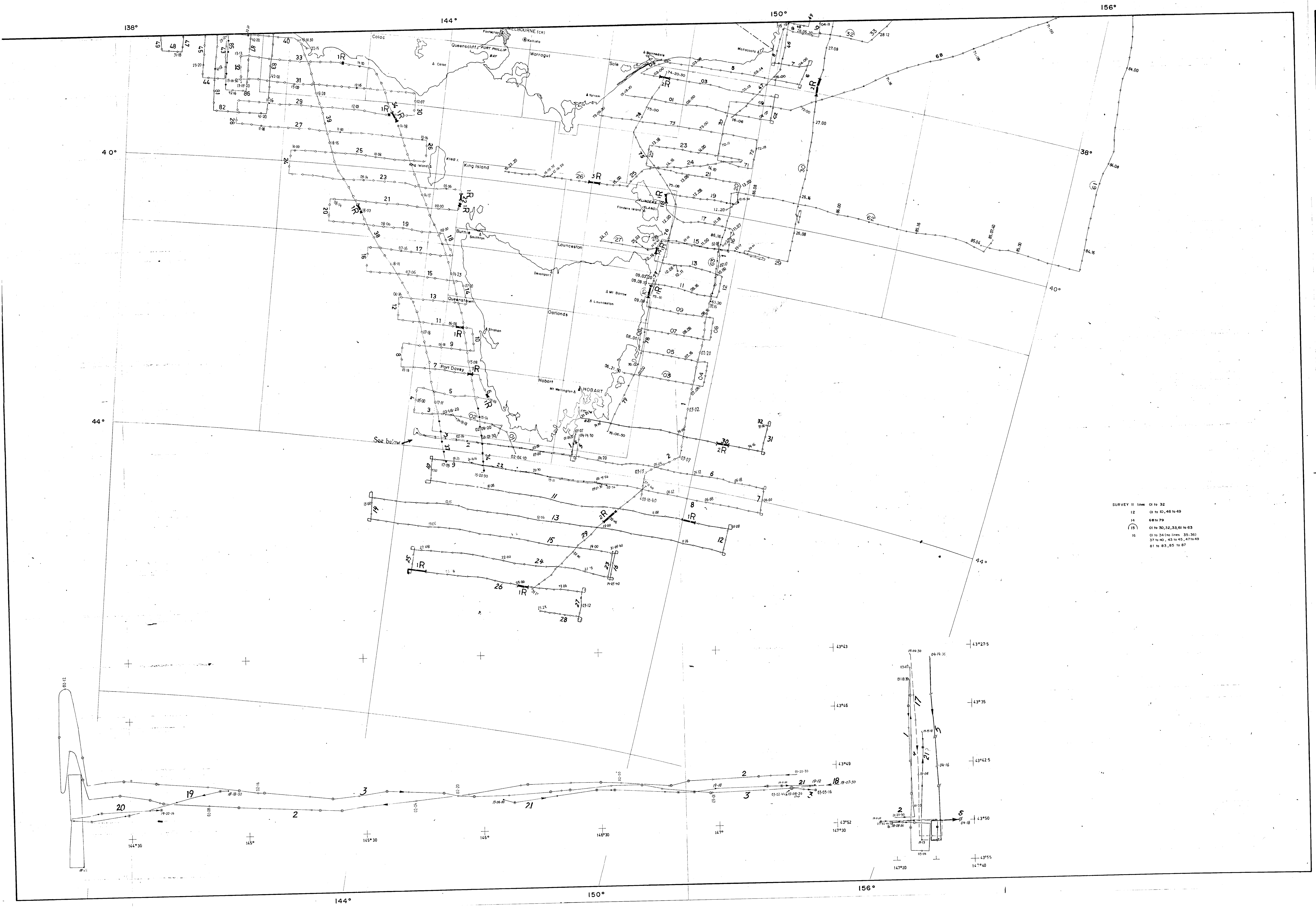
COMPAGNIE GENERALE DE GEOPHYSIQUE

SURVEY 12 lines 10 to 46,48 to 106
13 01 to 45,80
14 01 to 02, 61 to 68
15 30,31,33 to 61

SOUTH PACIFIC OCEAN

TASMAN SEA

150° 156° 24° 28° 32° 36°



BUREAU OF MINERAL RESOURCES

ENCL. 8

GEOPHYSICAL SURVEYS OF THE CONTINENTAL MARGINS OF AUSTRALIA, GULF OF PAPUA AND THE BISMARCK SEA

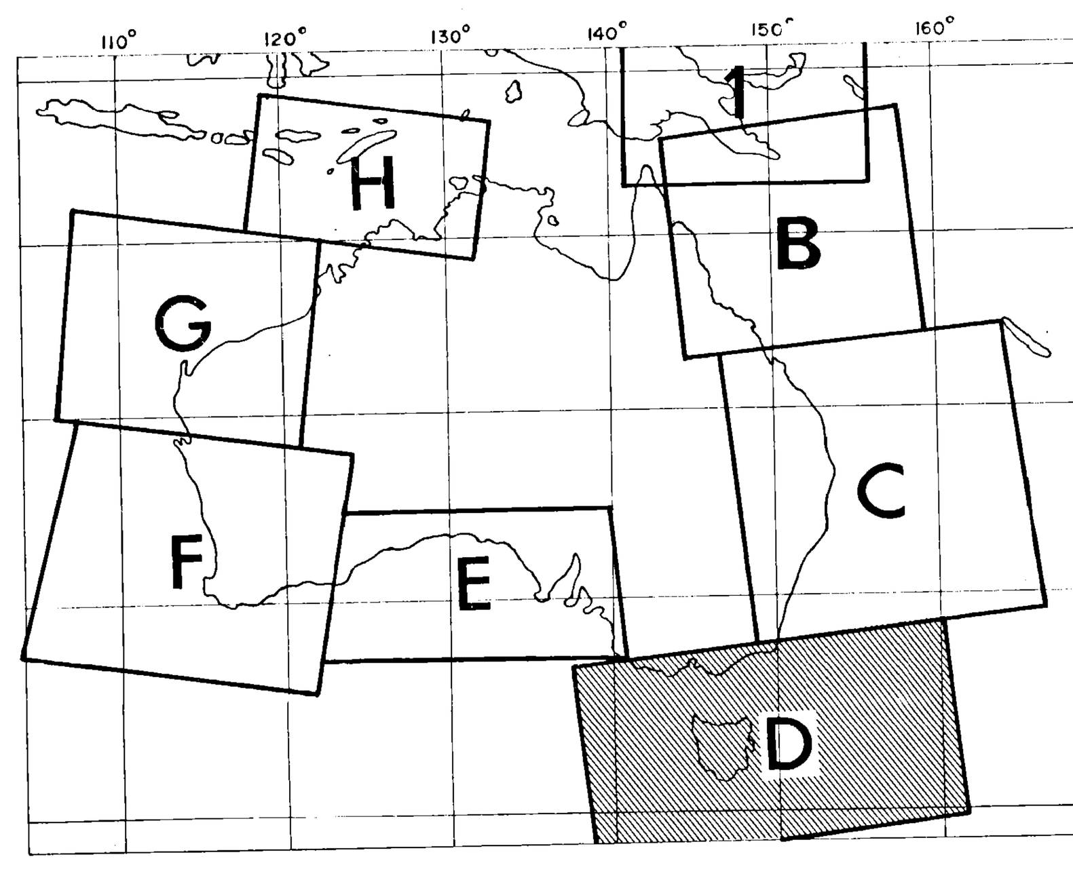
LOCATION MAP

SONOBUOYS

LEGEND

HOURLY POSITION

2R REFRACTION PROBE AND NUMBER OF SONOBUOYS USED



COMPAGNIE GENERALE DE GEOPHYSIQUE

BUREAU OF MINERAL RESOURCES ENCL. 9

GEOPHYSICAL SURVEYS OF THE CONTINENTAL MARGINS OF AUSTRALIA, GULF OF PAPUA AND THE BISMARCK SEA

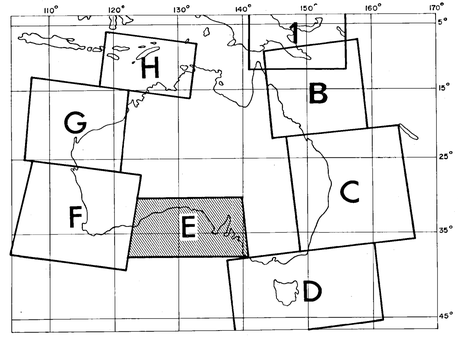
LOCATION MAP

SONOBUOYS

LEGEND

HOURLY POSITION

2R REFRACTION PROBE AND NUMBER OF SONOBUOYS USED



COMPAGNIE GENERALE DE GEOPHYSIQUE

126°
132°
138°
30°
32°
34°
36°
38°

BUREAU OF MINERAL RESOURCES

ENCL.10

GEOPHYSICAL SURVEYS OF THE CONTINENTAL MARGINS OF AUSTRALIA, GULF OF PAPUA AND THE BISMARCK SEA

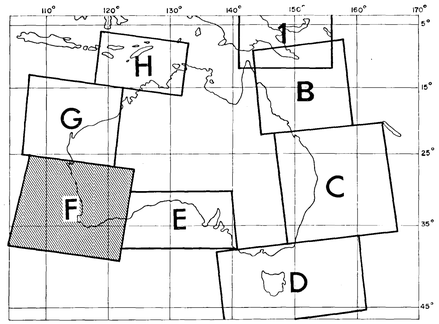
LOCATION MAP

SONOBUOYS

LEGEND

HOURLY POSITION

2R REFRACTION PROBE AND NUMBER OF SONOBUOYS USED



COMPAGNIE GENERALE DE GEOPHYSIQUE

108°
114°
120°
28°
32°
36°
Murgoo
Cue
Sandstone
Str Samuel
Duketon
Ajana
Yalgoo
Kirkalocka
Yaamni
Leonora
Laverton
Mason
Geraldton
Mullewa
Perenjori
Ninghan
Paries
Menzies
Edjudina
Minigwal
Moora
Bencubbin
Jackson
Kalgoorlie
Kurnalpi
Cundeelee
Hill River
Widgemooltha
Zanthus
Kellerberrin
Southern Cross
Boorabbin
Perth
Fremantle
Norseman
Balladonia
Corrigin
Hyden
Lake Johnston
Esperance
Malcolm
Dumbleyung
Newdegate
Ravensthorpe
Busselton
Collie
Bunbury
Bridgetown
Pemberton
Mount Barker
Bremer Bay
Augusta
Albany
Mondrain Island

BUREAU OF MINERAL RESOURCES ENCL.11

GEOPHYSICAL SURVEYS OF THE CONTINENTAL MARGINS OF AUSTRALIA, GULF OF PAPUA AND THE BISMARCK SEA

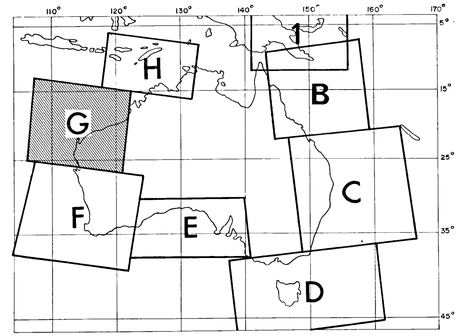
LOCATION MAP

SONOBUOYS

LEGEND

HOURLY POSITION

2R REFRACTION PROBE AND NUMBER OF SONOBUOYS USED



COMPAGNIE GENERALE DE GEOPHYSIQUE

111° 114° 117° 120°

108° 111° 114° 117°

17° 20° 23° 26°

Pender Broome La Grange Munro Anna Plains Mandora Bedout Island Port Hedland Roebourne Dampier Barrow Island Yarrie Ankatell Marble Bar Nullagine Pyramid Yarraloola Onslow Wyloo Mt Bruce Roy Hill Balfour Downs HAMERSLEY RANGE Fortescue River Ashburton River Newman Robertson Turee Creek Edmund Winning Pool Minnya Mt Egerton Mt Phillips Kennedy Range Quobba Gascoyne River Glenburgh Robinson Range Carnarvon Woorarnel Shark Bay Ningaloo Yanrey Byro Belele Yalinga

GEOPHYSICAL SURVEYS OF THE CONTINENTAL MARGINS OF AUSTRALIA, GULF OF PAPUA AND THE BISMARCK SEA

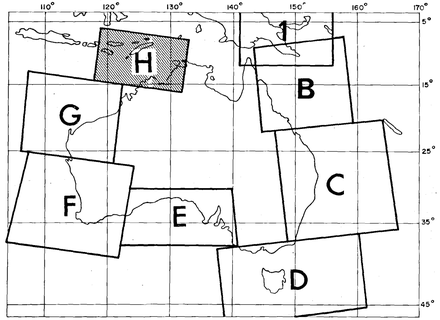
LOCATION MAP

SONOBUOYS

LEGEND

HOURLY POSITION

2R REFRACTION PROBE AND NUMBER OF SONOBUOYS USED



COMPAGNIE GENERALE DE GEOPHYSIQUE